COMP4801

Final Year Project

An All-in-one HKU App for Students

Detailed Project Plan

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List of Abbreviations

Abbreviation	Definition
API	Application Programming Interface
CSE	Centre for Sports and Exercise, University of Hong Kong
GCP	Google Cloud Platform
GPT	Generative Pre-trained Transformers
gRPC	gRPC Remote Procedure Calls
HKU	The University of Hong Kong
ITS	Information Technology Services of The University of Hong Kong
UI	User Interface
UX	User Experience
SDK	Software Development Kit
SSO	Single Sign On
SAML	Security Assertion Markup Language

Project Background

The current digital products at HKU present a fragmented user experience. Student resources are scattered across various platforms. Students often need to search for the resources to locate the correct webpage. The primary interface, HKU Portal, lacks mobile optimization and uses outdated user interface by modern standards. Other universities in Hong Kong have been able to create a mobile-friendly web or app with less clutter and higher efficiency (e.g. HKUST Student, USThing, PolyULife). Moreover, HKU lacks an unified community for students to review courses or promote student societies' activities, failing to foster a warm-community atmosphere within the campus to new and current students.

In November 2022, OpenAI launched ChatGPT and unexpectedly soared in popularity, reaching 100 million users by January 2023. Its swift popularity was due to its sophisticated language understanding and generation capabilities, enabling more human-like and engaging interactions by generating different novel scenarios according to the given prompt [1]. This development has casued the emergence of chatbots that combined an organization's knowledge base with GPT-powered generation, offering personalized user experiences without requiring extensive application navigation. Developers have harnessed ChatGPT's advanced reasoning skills for comparing, extracting, and clustering diverse and different ideas, simplifying the creation of recommendation systems.

This project aims to tackle the pressing necessity to address the digital confusion that hinders student engagement and efficiency at HKU. The envisioned mobile application seeks to amalgamate various student-centric functionalities into a singular, user-friendly, intuitive and modern platform. By potentially leveraging web scraping technology or obtaining API access from ITS, the app aims to aggregate essential data from HKU Portal, simplifying access to academic data, facility bookings, and campus events, while implementing intelligent and nice-to-have features like course reviews, GPT-powered friendship pairings, smart notifications and an intelligent chatbot with extensive knowledge of the student's information to improve and enrich student's campus life.

Project Objective

Upon project completion, a functional iOS app, complemented by backend services in the cloud, will be developed, aiming to offer the following features:

1. Retrieval of data including:
    a. GPA/ Transcript
    b. Course history along with grades
    c. Course catalogue
    d. Course timetable
        i. Automatic integration with local calendar app
        ii. Shown in a widget within iOS
    e. Exam Timetable (if available)
    f. Invoice
2. Smart notifications to remind students:
    a. Add/drop period
    b. Course timetable
    c. Exam timetable
    d. Invoice due date
3. Facility booking:
    a. Discussion rooms at HKU Chi Wah Learning Commons and Libraries
    b. CSE's gym and sports facilities
4. Simple course ratings:
    a. Only students who have completed the particular course are eligible to rate
    b. Leave comments, star ratings and what grades did they receive
    c. Tag the courses with simple categories such as high workload or "leng" (good) grade
    d. View the professor or lecturer's other courses as well
5. Campus events:
    a. Student societies can publish their events on the platform
    b. Title, description, location and images can be added
    c. Categorized into groups like academic, sports or hangout
    d. Students can reserve their spots, and organisers will receive a list of interested students
    e. Share activities to other students with a link
    f. Notifications to remind students regarding the start date or push new updates to students on behalf of the organisers

6. Friendship pairing:
    a. Students can input the following for matching with or searching for other students:
        i. What sort of person they are looking for to be friends with
        ii. Common courses they have
        iii. Hobbies, sports
        iv. Other after-school activities
    b. They can browse the summarised list of other students
    c. The system will recommend similar students periodically
    d. Real-time chat feature for communication
7. Lunch buddy pairing:
    a. Based on current location obtained via Global Positioning System
    b. Automatic filtering based on
        i. Dietary restrictions
        ii. Personal cuisine type preference
    c. Real-time chat feature for communication
8. Intelligent chatbot
    a. Students can interact with the chatbot in a conversational manner
        i. Ask for general advice or just chit-chat
    b. The chatbot will utilize basic information of the particular student as context
    c. The chatbot will be able to reference scraped HKU data to ensure accuracy and avoid “hallucinations”
        i. Course catalogue
        ii. Exchange studies
        iii. Major, Minors
9. Secure:
    a. Users will need to be authenticated to access the data
    b. Encryption for sensitive data
    c. Secure and verified communication between the app and backend services
    d. Minimal data storage in the backend database

Project Methodology

iOS App

The iOS platform has been selected due to its renowned stability and optimization for application development. The application will be built with Swift and SwiftUI, as these frameworks are natively supported by iOS and are endorsed by Apple due to their incorporation of modern programming language features, alongside exceptional efficiency and safety considerations[2]. Swift facilitates the utilization of various native SDKs provided by Apple, enabling developers to access invaluable SDKs such as the keychain services for secure data storage and WidgetKit for the development of widgets. Additionally, native iOS features like Spotlight search, share sheet, and Mac Catalyst will be explored, as they contribute to a seamless user experience within the iOS ecosystem.

UI and UX

A comparative review of similar applications in the market, such as USThing and PolyULife, will be conducted to have a general understanding of prevailing UI/UX designs while identifying less favourable or unpleasant aspects. The primary UI/UX design of the application will strive to adhere to Apple's Human Interface Guidelines for iOS applications as closely as possible to ensure consistency across different sections and alignment with other iOS applications.

Figma will be used for UI design, due to its capability for rapid prototyping and sketching of UI/UX elements with free access. The application will be organized into distinct sections, each accompanied by a corresponding icon and title to enhance readability and ease of use.

Backend Service Implementation

The backend service will be implemented using GoLang, selected for its efficiency, type-safety, and modern programming language features and syntax. Communication between the client (iOS application) and the backend service will be facilitated via gRPC, aided by protocol buffers. In comparison to the conventional approach using JavaScript Object Notation (JSON) schema and RESTful API, gRPC with protocol buffers exhibits superior speed in certain scenarios, offers idiomatic client libraries in both GoLang and Swift, and supports bi-directional streaming along with a straightforward service definition. This definition specifies the remote method’s parameters and return types. Additionally, gRPC in mobile application development can leverage gRPC’s streaming and connection features to conserve bandwidth and reduce loading time [3]. The gRPC service will be hosted on GCP Cloud Run, given its full support for gRPC's requirement of utilizing HTTP/2, alongside its acclaimed ease of use and simplicity.

For authentication, session management, Postgres database hosting, storage, and real-time communication, Supabase, an open-source alternative to Firebase, will be used. The project aims to integrate ITS’ SSO system, connecting to Supabase’s authentication service via

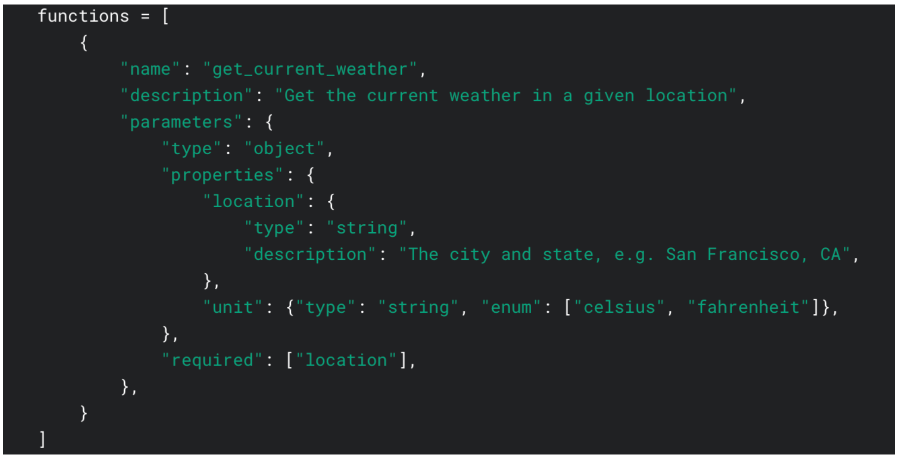
SAML version 2.0. This integration allows students to seamlessly sign-in to the application using their HKU Portal UID and PIN. Supabase has also been chosen due to its implementation of Row-Level Security, ensuring that only authenticated users with the required permissions can access specific rows in a table. A significant advantage of utilizing a Postgres database is its support for storage and indexing of vectors in a column through an extension called “pgvector.” Vectors can be used to aid GPT models to retrieve similar contexts and help generating more precise responses. Furthermore, Supabase’s Realtime service facilitates the implementation of a real-time chat service [4].

OpenAI APIs Integration

To mitigate the potential abuse and misuse of the chatbot, OpenAI's Moderation API will be employed to ensure that user prompts or queries adhere to OpenAI's usage policy, thereby filtering out undesirable content. Given the prevalence of mental health issues in Hong Kong, if the Moderation API flag and categorize content as "self-harm," the application will redirect the user to relevant online resources and HKU's counselling services to provide the necessary assistance. The application will forward a chat completions request to the backend only after ensuring the content is appropriate.

For the chatbot to provide contextually relevant and accurate information with customized chat generation, the project will scrape various HKU resources such as exchange studies information, course details, timetables, and academic offerings like available majors or minors. Upon data retrieval and segmentation into sub-sections, the data will be fed into OpenAI's Embeddings API to convert them into embeddings—a vector list of floating-point numbers—which will then be stored within the Postgres database. These embeddings quantify the relatedness of text strings and can be utilized to calculate the "distance" (i.e., the relatedness) between the user query and the actual data in the database. This mechanism facilitates search, recommendation, and data clustering for the GPT model, enhancing the analysis and chat generation processes.

Furthermore, the project will leverage the Chat Completions API. Each of the messages sent to API are assigned with roles as either "system," "assistant," or "user." The "assistant" and "user" roles correspond to the GPT model's messages and the actual user (student) respectively, while the "system" role serves to dictate the model's behaviour and provide specific instructional directives regarding response formatting or requirements. The "system" role will be used to provide relevant context for the GPT model to analyse and specify the appropriate format for message delivery, enriching the contextual understanding.



```
functions = [
    {
        "name": "get_current_weather",
        "description": "Get the current weather in a given location",
        "parameters": {
            "type": "object",
            "properties": {
                "location": {
                    "type": "string",
                    "description": "The city and state, e.g. San Francisco, CA",
                },
                "unit": {"type": "string", "enum": ["celsius", "fahrenheit"]},
            },
            "required": ["location"],
        },
    }
]
```

Fig. 1. Chat completions API's request's "functions" property for function calling feature. Adapted from [5]

For the friendship pairing feature, the function calling capability within the Chat Completions API will be used. As depicted in Fig. 1, the Chat Completions API accommodates an array of different functions detailing the actual function and the properties it accepts, including their types. This feature can be actualized by supplying a list of students, each accompanied by a brief summary, and tasking the GPT model with a well-structured prompt to compare the user-supplied personal description against the list of summaries. Should the GPT model be able to make a match with one of the supplied students confidently, it can invoke one of the predefined functions with the arguments supplied by GPT and automatically match similar students together.

Project Schedule and Milestones

Period	Deliverables and Milestones
September 2023	– Meeting with project supervisor – Planning project – Setting up webpage – Obtaining API access from OpenAI
October 2023	**Research:** – Conducting literature review on similar applications – Reviewing iOS app design guidelines from Apple – Learning Swift and SwiftUI – Inquiring with ITS about the possibility of utilizing SSO system to authenticate users and retrieve HKU Portal's data **Implementation:** – Setting up GitHub Repo, iOS development environment, and Supabase – System Design (Database, Backend Design)
November 2023	**Research:** – Studying the feasibility of web scraping HKU Portal or other facilities booking data **Implementation:** – Designing basic UI/UX with Figma – Implementing essential backend services (Authentication, Database schema)
-	**Milestone 1:** **– Software analysis and design are completed at this stage. Software development should begin at this stage.**
December 2023 – January 2024	**Research:** – Exploring OpenAI API functionalities (Moderation, embeddings, chat completions, and function calling) **Implementation:** – Starting implementation of iOS app – Implementing backend services (Facility bookings, web scraping, and course reviews/ratings)
-	**Milestone 2:** **– A functional prototype should be developed in this stage and made available for distribution to users for testing purposes.** **– The app should have the capability to retrieve basic information from the HKU Portal and facilitate facility bookings.**

February 2024	**Research:** – Prompt engineering (Training GPT-4 model to match similar people or personality and answering HKU-related data**)** **Implementation:** – Scraping HKU-related data and create embeddings (Exchange studies, courses data) – Implementing backend services (Friendship pairing, lunch buddy pairing and campus events)
March 2024	**Implementation:** – Implementing OpenAI APIs (Moderation, creating embeddings, and chat completions) – Implementing backend services (Real-time chats) – Bug-fixing and improving software products based on tester's feedback
April 2024	**Final Wrap-up:** – Finalizing report, presentation, website and product

References

[1] A. Chow, “How ChatGPT Managed to Grow Faster Than TikTok or Instagram,” *Time*, Feb. 08, 2023. https://time.com/6253615/chatgpt-fastest-growing/.

[2] “Swift - Apple Developer,” Apple. https://developer.apple.com/swift (accessed Sep. 30, 2023).

[3] “Documentation,” *gRPC*. https://grpc.io/docs (accessed Sep. 30, 2023).

[4] “The Open Source Firebase Alternative,” *Supabase*. https://supabase.com (accessed Sep. 30, 2023).

[5] OpenAI, “OpenAI Platform,” *platform.openai.com*. https://platform.openai.com/docs/guides/gpt/function-calling (accessed Oct. 01, 2023).