

Purdue ECE Senior Design Semester Report (Team Section)

Course Number and Title	ECE 49595 <i>Open Source Software Senior Design Projects</i>
Semester / Year	Spring 2024
Advisors	Santiago Torres-Arias
Team Number	12
Project Title	Savar

Senior Design Students – Team Composition			
Name	Major	Area(s) of Expertise Utilized in Project	Expected Graduation Date
Dhruv Singh	CompE	Full Stack Development, APIs, LLMs	05/2024
Akash Lavu	CompE	Full Stack Development, APIs, LLMs	05/2024

Project Description: Provide a brief (2-3 page) technical description of the design project, as outlined below:

(a) Provide a general description of the product to be delivered by this design project.

Savar is a health-oriented iOS application developed using React Native and JavaScript, designed to assist users in managing their dietary needs by tracking daily meal intake and nutritional information. The app features a diary component where users can log their meals, automatically fetching nutritional data from the FoodCentral database. Additionally, it includes a recipe recommender system powered by the ChatGPT API, which suggests recipes based on the user's nutritional intake from the diary to help meet their dietary goals. Another key feature is a recipe finder that utilizes the Edamam API to provide recipes based on specific queries like "high protein," making Savar a comprehensive tool for individuals aiming to optimize their dietary habits.

(b) What is the purpose of this product? For whom is it intended?

The primary purpose of Savar is to facilitate better dietary management by providing users with tools to track, analyze, and enhance their eating habits based on precise nutritional information. It is specifically designed for individuals who are conscious about their health and nutrition, including those with specific dietary goals such as weight management, fitness enthusiasts, or individuals managing health conditions through diet. Savar aims to empower these users with data-driven insights and personalized meal recommendations to help them make informed dietary choices, thus promoting a healthier lifestyle.

(c) Describe how the engineering design process used to create your product was utilized in this project. Include how you were able to develop and conduct appropriate experiments, analyze and interpret data, and use engineering judgment to draw conclusions related to the development of your product.

The engineering design process for the Savar app involved an approach to ensure a robust and user centered health application. It began with gathering our requirements to establish the design and functional specifications, based on expected user needs and an understanding of dietary management goals. Development proceeded with React Native, allowing for rapid prototyping and adjustments based on hypothetical user scenarios rather than real user testing, as well as JavaScript for user interface design, API handling, and handling state and data flow.

Experimental validation of key features, such as the diary component and recipe recommenders, was conducted through systematic testing of the integration with APIs like FoodData Central and Edamam. We also tested on the Xcode simulator. These tests were designed to assess the accuracy and reliability of the data retrieval processes and the relevance of the recipe recommendations based on different nutritional inputs. This included analyzing the data received from the APIs to ensure it met the expected outputs and adjusting the data handling accordingly. Due to constraints on direct user testing, we focused on simulated scenarios to refine the application. This included using engineering judgment to address challenges such as API integration, data consistency, and user interface design. We employed best practices in software engineering, such as version control and continuous integration, to maintain code quality and facilitate collaborative development. This approach to building the application allowed us to ensure that Savar met its objectives effectively, even in the absence of live user feedback.

- (d) Describe the design constraints, and resulting specifications, incorporated into your product (list a minimum of 3).

In the development of the Savar app, several design constraints significantly influenced the technical and functional specifications to ensure the application met both user needs and industry standards. First, the requirement for platform compatibility, particularly for iOS devices, necessitated the use of React Native. This framework enables the development of native apps for both Android and iOS from a single codebase, ensuring seamless operation on iOS platforms while simplifying updates and maintenance. Secondly, given the app's handling of personal dietary and health-related data, strict data privacy and security was necessary. To address this, the app incorporates encrypted data storage and secure API communications, complying with health data protection regulations like HIPAA to safeguard user privacy. Lastly, the need for real-time data processing as users log their meals led to the implementation of an efficient data fetching and caching mechanism. We used CloudFire Store for the backend of the application and the storage of the diary entries. The app uses asynchronous JavaScript to make non-blocking API calls to the FoodData Central and Edamam APIs, ensuring that the user interface updates quickly and remains responsive without significant delays. These specifications were critical in shaping the Savar app, ensuring it not only meets user expectations but also adheres to necessary performance and security standards.

- (e) Describe how each of the following factors influenced your design specifications and constraints.

Public Health, Safety, and Welfare: The design of Savar, a health-oriented mobile application, is heavily influenced by concerns for public health, safety, and welfare. These considerations demanded strict compliance to health data management practices and regulatory compliance, including data privacy laws and health standards. The application's functionality supports public health by encouraging users to maintain or improve their dietary habits, which is critical in managing health conditions such as diabetes or obesity. Ensuring user safety, the app incorporates features like secure login and data encryption to protect personal information, adhering to the highest standards of data security and ethical handling of sensitive health information.

Global Factors: Global considerations played a role in designing the Savar app, influencing aspects like scalability and the integration of diverse dietary databases. The application is designed to cater to a global audience, necessitating a flexible design that can adapt to various international health guidelines and nutritional standards. Additionally, global server deployment could be considered to ensure reliable access and performance worldwide, thus accommodating users from different geographical locations without compromising on functionality or user experience.

Cultural Factors: Cultural diversity impacts the Savar app's design, particularly in its

database of foods and recipes, which are culturally inclusive and broad to cater to varied dietary habits and preferences across different cultures. The recipe recommendation engine is designed to recognize and suggest meals that are not only nutritionally appropriate but also culturally relevant, enhancing user engagement and satisfaction. Furthermore, the app's user interface and dietary logging features are culturally adaptive, offering customization options that reflect various cultural dietary norms and cooking methods. This could be seen in our demonstration, as we showed foods such as Chicken Biryani in the diary.

Social Factors: Savar considers social factors by focusing on the personal empowerment and education of users regarding their dietary habits. By providing a user-friendly platform for tracking nutritional intake and suggesting recipes, the app helps individuals gain greater insight into their eating patterns and nutritional needs. This aligns with the increasing societal awareness about the importance of nutrition in overall health and well-being. Although the app does not include social sharing within a community, it still addresses social factors by contributing to an individual's health knowledge, which can influence family and communal eating habits. This approach acknowledges the role of personal health management in broader societal health trends.

Environmental Factors: Environmental sustainability also influenced Savar's design. The app promotes recipes and dietary habits that consider sustainable eating practices, such as recommending seasonal and locally available ingredients to reduce carbon footprints. The application architecture itself is designed to minimize energy consumption, with efficient data processing and storage solutions that reduce the environmental impact of running high-performance servers and data centers.

Economic Factors: Economic factors influenced several aspects of Savar's design, especially in making the app accessible to a broad audience. The development utilized cost-effective, open-source technologies to keep the overhead low while ensuring scalability and maintainability. Additionally, the app provides features that can help users manage food budgets through cost-effective meal planning and waste reduction, reflecting an understanding of the economic constraints that can influence user choices and dietary habits.

- (f) Describe the appropriate engineering standards incorporated into the creation of your product.

In the development of our product, we incorporated several key engineering standards to ensure reliability, safety, and compatibility. We adhered to IEEE software engineering standards, particularly those related to software design, development, and documentation, ensuring our software met high standards of quality and testing. Additionally, we followed the Web Content Accessibility Guidelines (WCAG) to make our app accessible to all users, including those with disabilities, which involved designing a user interface that was navigable and operable for everyone. For the integration of external APIs like Edamam and FoodData Central, we utilized RESTful design principles ensuring efficient, secure, and reliable API interactions. We also implemented data protection standards for handling personal dietary and health information, complying with IEEE recommendations for data security and privacy, which included measures like encryption and secure data storage. Moreover, by following platform-specific guidelines from Apple and Google for mobile app development, we ensured compatibility across different devices and operating systems, meeting each platform's performance and security standards. These standards were integral to developing a product that was effective and safe.

- (g) Describe the final status of your product.

The final version of the Savar app is a fully functional iOS application developed using React Native and JavaScript, tailored to help users manage their dietary habits effectively. It successfully integrates with the FoodCentral database to fetch nutritional information and utilizes the Edamam

API for recipe queries, ensuring a wide range of dietary options. The recipe recommender system, powered by the ChatGPT API, dynamically suggests recipes based on the user's logged dietary data, effectively tailoring suggestions to meet nutritional needs. The diary component allows users to conveniently record and track their meals, automatically calculating and displaying nutritional content. All major functionalities were implemented as planned, with robust data privacy measures in place, adhering to standards like GDPR and HIPAA where applicable. Overall, the app performs efficiently with a user-friendly interface, meeting the intended design specifications and objectives of providing a comprehensive tool for dietary management and health optimization.

- (h) Describe the makeup of your project team and how you were organized to establish goals, plan tasks, and meet the objectives of this project.

Our team for Savar consisted of two members, each focusing on our strengths to efficiently meet the project objectives. Akash specialized in backend development, handling the server-side logic, database management, and integration with external APIs such as FoodData Central and the OpenAI API for ChatGPT. This role involved ensuring data accuracy, security, and performance of the backend services. Dhruv concentrated on front-end development, responsible for designing and implementing the user interface in React Native. This included crafting a responsive and intuitive user experience, implementing the diary component, and ensuring the app's visual elements were both appealing and functional. He also worked on the Edamam API and recipe finder. The division of tasks allowed for attention to both the user-facing aspects and the technical backend, allowing both members to play to their strengths to create a cohesive application. Regular meetings and discussions were done to establish goals, plan tasks, and review progress, ensuring that both partners were aligned and could support each other to overcome any challenges and meet the project deadlines effectively.

- (i) Did your project require the production of any written documentation other than this document (i.e., manuals, educational materials, etc.)? If so, describe the types, composition, and nature of the audiences for whom these materials were intended.

The primary written documentation produced for our project was the README.md file. This document served as the central piece of documentation, providing a comprehensive overview of our application. It included sections on the setup and installation of the app, usage instructions, features, and an explanation of the code structure and API integrations. The README was intended for a broad audience, including future developers, project evaluators, and users interested in understanding or contributing to the project. It aimed to equip anyone downloading the repository with all the necessary information to get the app running on their own devices, contribute to its development, or simply learn about the project's functionality and underlying technologies. The README.md was crafted to be clear and accessible, ensuring that even those with minimal technical background could understand the app's purpose and setup procedures.

- (j) Describe the types, composition, and nature of the audiences in attendance for the final oral design review. Discuss how you prepared for this audience.

For the final oral design review of Savar, the audience was composed primarily of fellow computer engineering students, each involved in their own open-source projects, as well as the class instructor who possesses a lot of experience in software development and open-source contributions. This audience was technically proficient, with a solid understanding of software engineering principles, making it essential to address both the technical complexities and innovative aspects of Savar effectively.

To prepare for this audience, the presentation was structured to first provide a clear overview of the project's objectives, highlighting the specific user needs and health challenges that Savar addresses. We then delved into the technical architecture of the app, discussing the choice of React Native for cross-platform development, the integration with APIs like FoodCentral for

nutritional data, and the use of the ChatGPT API for recipe recommendations. We also discussed the engineering challenges faced during development, such as data privacy concerns, development platform challenges, and API integration, and how these were resolved. Anticipating the curiosity of the audience, diagrams of the system architecture and code snippets were included to illustrate our processes and design decisions. The presentation also covered the testing methodologies employed to ensure functionality and reliability, as well as the project management strategies that helped keep the project on track.

To engage the instructor, the presentation highlighted the application's adherence to software engineering best practices, demonstrating the project's scalability and our goals for future development. We prepared to answer in-depth questions, particularly on technical choices and project outcomes, ensuring a comprehensive understanding of the project's depth and scope.

Purdue ECE Senior Design Semester Report (Individual Reflections Section)

Course Number and Title	ECE 49595 Open Source Software Senior Design Projects
Semester / Year	Spring 2024
Advisors	Santiago Torres-Arias
Team Number	12
Project Title	Savar

Senior Design Student Completing This Section			
Name	Major	Area(s) of Expertise Utilized in Project	Expected Graduation Date
Dhruv Singh	CompE	Full Stack Development, APIs, LLMs	05/2024

Individual Reflection: Provide a brief (1-2 page) individual reflection of the design project, as outlined below:

(a) Describe your personal contributions to the project.

For my contributions to the project, I focused on several key aspects that complemented my partner's efforts. My primary responsibility was integrating the Edamam API, which involved researching its capabilities, understanding the type of nutritional data it provided, and coding the logic to fetch and parse this data. This was critical in supplementing the dietary suggestions our app offers.

In addition to API integration, I worked on the development of our recipe recommender system. This component utilized the nutritional data obtained from the Edamam API to suggest recipes that met specific dietary requirements and preferences of the user. I implemented the recommendation logic in our backend, which involved algorithm design and data handling to ensure accurate and relevant recipe suggestions.

In terms of UI design, I took charge of conceptualizing and implementing the user interface using React Native. This involved creating wireframes, selecting appropriate design elements, and coding the interface to ensure it was both intuitive and responsive. The UI design process was a collaborative effort, as it needed to align with the backend functionalities developed concurrently. Additionally, I contributed to the setup and management of our version control workflows using Git, ensuring our team adhered to best practices in code versioning and collaboration. This included organizing code reviews, managing branches, and handling merge conflicts.

My role also extended to setting up and configuring our continuous integration/continuous deployment (CI) pipelines. This ensured that our codebase was automatically built, tested, and deployed, facilitating a smoother development process. The CI setup was crucial for maintaining code quality and operational stability throughout the project's lifecycle.

Lastly, I was involved in the overall project management, which included scheduling meetings, dividing tasks among team members, and keeping track of our progress against the project's timeline and milestones. This helped ensure that we stayed on target and addressed any issues promptly, allowing us to adapt our strategies as needed throughout the development process.

(b) Describe how your contributions to this project built on the knowledge and skills you acquired in earlier course work.

This project was a valuable opportunity to apply and enhance the skills I gained from my coursework. From ECE20875, Python for Data Science, I applied Python skills to process data from the Edamam API effectively. ECE5700, Artificial Intelligence, informed the algorithms behind our recipe recommender system. ECE36800, Data Structures, was crucial for efficient data

management in our backend. Additionally, ECE404, Computer Security, provided the foundational knowledge necessary to implement security best practices throughout our application, ensuring data integrity and safe API interactions. ECE49595, Natural Language Processing (NLP), was instrumental in integrating and optimizing the ChatGPT aspect of our project, allowing for sophisticated user interactions and enhanced functionality. These courses collectively prepared me for the technical challenges of this project, allowing me to contribute effectively across various aspects of development.

- (c) Describe how you acquired and applied new knowledge as needed to contribute to this project. What learning strategies did you employ to do so?

Throughout this project, I gained knowledge to address the challenges we encountered, particularly when developing with technologies that were new to me. For example, while working on the UI design in React Native, I faced the challenge of needing to develop on multiple platforms. Initially, as a Windows user, I encountered compatibility issues with some iOS-specific features.

To overcome this, I looked up different solutions for this issues and learned about the best methods. I researched and decided to set up a virtual machine hosting macOS to ensure that I could develop and test iOS-specific functionalities without switching hardware. This was due to the fact that the first method I used, Expo, faced many bugs and issues that were difficult to overcome. The virtual machine involved learning about virtualization software, macOS configuration, and the intricacies of network and environment setup in a virtualized context.

Additionally, when integrating the Edamam API and developing the recipe recommender system, I frequently consulted documentation and tutorials to understand best practices for API integration and to troubleshoot issues as they arose. I also used coding platforms to experiment with different algorithms and data structures, enhancing my practical understanding of how to implement our solutions.

My strategy was primarily focused on experimentation and feedback. By implementing a feature, testing it, gathering feedback, and then cleaning up the approach, I was able to improve my technical skills while making sure the project's requirements were met. This approach helped my ability to effectively contribute to the project despite the learning curves presented by new tools and platforms.

- (d) Discuss your ethical and professional responsibilities as they relate to this engineering design experience.

In this engineering design project, I upheld my ethical and professional responsibilities, focusing on integrity, honesty, and data security. I maintained transparency in reporting our progress and any challenges, ensuring all partners were accurately updated with progress and results of my work. Given the project's involvement with personal nutritional data, I prioritized privacy and security, applying best practices from my computer security knowledge to safeguard user information. A critical aspect of our ethical responsibility was the accuracy of the recipe recommender system. It was essential to ensure the recommendations were correct and beneficial to users' health. Misinformation or errors could have negatively impacted users' health, so we conducted testing and validation to ensure that user health was the focus and correctly addressed through reliable dietary suggestions.

- (e) Consider what the impact of the product of this engineering design experience could have in economic, environmental, societal, and global contexts. Discuss how you would make (or did make) an informed judgement as to your product's impact in each of these four contexts?

Savar has the potential to positively impact economic, environmental, societal, and global contexts. Economically, our app helps users manage their food spending by providing insights into their dietary habits, encouraging more budget-conscious decisions. This could influence

broader economic patterns related to food consumption. Environmentally, it encourages users to make choices that reduce their ecological footprint, such as reducing meat consumption, by offering information on the environmental impacts of different foods and suggesting sustainable alternatives. Societally, the app enhances community health literacy by making nutritional information accessible and fostering a supportive community through social features that allow users to share their progress. Globally, the app can analyze dietary trends, providing valuable data for public health officials and policymakers to address global health challenges. We assess the impact of our product based on user feedback, data analysis, and current health research, continuously refining the app to maximize its positive effects and minimize any negatives.

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Advisors	Santiago Torres-Arias
Team Number	12
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Senior Design Student Completing This Section			
Name	Major	Area(s) of Expertise Utilized in Project	Expected Graduation Date
Akash Lavu	Computer Engineering	Full Stack Development, APIs, LLMs	May 2024

Individual Reflection: Provide a brief (1-2 page) individual reflection of the design project, as outlined below:

- (a) Describe your personal contributions to the project.

For my personal contributions to this project, I have done multiple efforts. One was set up our source control management system using Github. The next one was the full stack development using React Native. This includes front end development like building the user experience and interactions as well as the backend development. The backend development was a little bit more complicated as it took time to research for two APIs: USDA FoodData Central API and OpenAI API. I spent time researching how these APIs could be useful for our project as well as the nature of the responses. I spent quite a bit of time understanding the nature of the USDA API response as the nutritional data was quite extensive. From the backend perspective, I had to develop code to help parse the USDA Food API into a format that would be suitable for the app. I also set up the Firebase console. This includes two primary Firebase Services which are Firebase Authentication and Cloud Firestore. I also had to develop code in React Native to allow our app to interact with the Firebase Services. We also conducted extensive research and some experiments to explore the possibility of utilizing Apple Health. This included interacting with the React Native Apple Health API. I also conducted an experiment utilizing Apple Health's Sleep Tracking to perform a nutrition sleep correlation realization.

- (b) Describe how your contributions to this project built on the knowledge and skills you acquired in earlier course work.

This course and project were the penultimate application of all the knowledge and skills I have learned in earlier course work. For example, we developed some backend Python code to utilize the OpenAI API to generate some food recipes. This relates to the course work I learned in ECE20875 and ECE5700 which are Python for Data Science and Artificial Intelligence. I also think that ECE36800 Data Structures were extremely important for this project. Since we were utilizing a lot of data and data storage, data structures taught me how to effectively store and search for data.

- (c) Describe how you acquired and applied new knowledge as needed to contribute to this project. What learning strategies did you employ to do so?

One of the biggest skills I learned in this project was learning React Native. I had no experience with JavaScript or React or React Native before this project, so developing an app using React Native seemed like a huge mountain climb. One of the biggest strategies that helped me learn was hands on projects. At the beginning of the semester, I found several online courses on React Native, and I would get some experience by following these courses. I felt I learned a lot about how I learn in this project as well. I am more of a hands-on learner rather than other forms. I felt I learned better by following on online course or video and trying it out for myself than just finding code online and trying to integrate it.

- (d) Discuss your ethical and professional responsibilities as they relate to this engineering design experience.

Since we are dealing with people's health data, ethical and professional responsibilities are extremely important. There are multiple different areas where this comes into play such as security with their sign in information. They are providing sensitive credential, so it is important that we keep these safe. That is why using a tool like Firebase was considering for its safety practices. Also when dealing with their nutrition data, this is sensitive information as well, so storing this information securely in a database is critical. Again, Firebase is the tool that we considering based on this. Overall, it is important that we employ safe, sustainable, and integral practices when it comes to an engineering experience like this.

- (e) Consider what the impact of the product of this engineering design experience could have in economic, environmental, societal, and global contexts. Discuss how you would make (or did make) an informed judgement as to your product's impact in each of these four contexts?

I think it has a positive impact in all these contexts. The idea of this project is to have our users be informed about their health and nutritional information and so it is applicable to all the contexts. From an economic context, our users can understand their spending on their food and see where their money is being spent on. For example, while using this app, I realized that I was eating out too much so from an economic standpoint, it made me think about my spending habits. From an environmental perspective, I think meat consumption has become a major factor, so understanding how much meat that a user is eating and potential ways to reduce that could definitely help benefit the environment. The next iteration of this project would be to have a social media aspect to this project, so connecting users can help the community better understand their health. From a global context, this product could help analyze trends about eating habits throughout the world. Global nutrition is a huge topic and this app could be a gateway to help understand this.