**Machine Learning Web App for Gourmet Recipe Recommendations Using Exotic Fruits for Food Connoisseurs.**

**Lawrence Remulo**

**146798**

**Submitted in partial fulfilment of the requirements of the Bachelor of Business in Information Technology at Strathmore University**

**Faculty of Information Technology**

**Strathmore University**

**Nairobi, Kenya**

**September 2024**

Declaration

I hence declare that this project has not previously submitted for degree at this or any other university or higher learning institution. To my understanding, the research proposal contains no material previously published or written by another person, except where proper references have been cited within the proposal.

Student Name: Lawrence Remulo

Admission Number: 146798

Student Signature: \_\_\_\_\_\_\_\_\_L.A.R\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_4/12/24\_\_\_\_\_\_

Supervisor Name: Zainabu Muti

Supervisor Signature:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Abstract

This proposal presents the case for developing a web-based application that leverages machine learning to provide gourmet recipe recommendations based on exotic fruits. Through a comprehensive review of existing literature, the proposal highlights the gap in current recipe platforms, particularly in their underutilization of exotic fruits in gourmet cuisine. The proposed system will address this need by offering users personalized, sophisticated recipe suggestions tailored to the characteristics of less-common fruits. Moreover, to cater to a niche of users within the culinary space.

The system design incorporates machine learning techniques, user-centered interfaces, and customizable recipe filters, ensuring an intuitive and enriching experience for food enthusiasts. The application will follow a structured development methodology and necessary software engineering techniques that emphasizes flexibility and continuous refinement, making it adaptable to user preferences and trends in culinary exploration.

Keywords: Recipe, Machine Learning, algorithm, app,

**Table Of Contents**

[Declaration ii](#_Toc183919983)

[Abstract iii](#_Toc183919984)

[List Of Figures vi](#_Toc183919985)

[List Of Abbreviation vii](#_Toc183919986)

[Chapter 1: Introduction 1](#_Toc183919987)

[1.1 Background 1](#_Toc183919988)

[1.2 Problem Statement 2](#_Toc183919989)

[1.3 Objectives 2](#_Toc183919990)

[1.3.1 General Objectives 2](#_Toc183919991)

[1.3.2 Specific Objectives 2](#_Toc183919992)

[1.4 Research Questions 2](#_Toc183919993)

[1.5 Justification For the System. 3](#_Toc183919994)

[1.6 Scope of the system. 3](#_Toc183919995)

[Chapter 2: Literature Review 4](#_Toc183919996)

[2.1 Introduction 4](#_Toc183919997)

[2.1.1 Interactions of users with recipe recommendation apps 4](#_Toc183919998)

[2.1.2 How the machine learning and algorithm involved works 4](#_Toc183919999)

[2.1.3 Challenges faced by users when interacting with recipe recommendation apps 5](#_Toc183920000)

[2.2 Technique 5](#_Toc183920001)

[2.3 Related Works 6](#_Toc183920002)

[2.3.1 Tasty 6](#_Toc183920003)

[2.3.2 Forks Over Knives 6](#_Toc183920004)

[2.3.3 Yummly 6](#_Toc183920005)

[2.3.4 Cookbooks 7](#_Toc183920006)

[2.4 Gaps in Related works 7](#_Toc183920007)

[2.5 Proposed System 7](#_Toc183920008)

[2.6 Conceptual Framework 9](#_Toc183920009)

[Chapter 3: Methodology 10](#_Toc183920010)

[3.1 Introduction 10](#_Toc183920011)

[3.1.1 Methodology to be used. 10](#_Toc183920012)

[3.2 Development approach Methodology to be used 10](#_Toc183920013)

[3.2.1 Backlog (To-Do Phase) 11](#_Toc183920014)

[3.2.2 In Progress (Development Phase) 11](#_Toc183920015)

[3.2.3 Review (Testing and Feedback Phase) 12](#_Toc183920016)

[3.2.4 Completed (Deployment Phase) 12](#_Toc183920017)

[3.3 Justification of the Kanban-Driven Incremental Development Methodology 12](#_Toc183920018)

[3.4 System Analysis 12](#_Toc183920019)

[3.4.1 Use Case Diagram 12](#_Toc183920020)

[3.4.2 Class Diagram 13](#_Toc183920021)

[3.4.3 Sequence Diagram 13](#_Toc183920022)

[3.4.4 Activity Diagram 13](#_Toc183920023)

[3.4.5 State Diagram 14](#_Toc183920024)

[3.5 System Designs 14](#_Toc183920025)

[3.5.1 Database Schema 14](#_Toc183920026)

[3.5.2 Wire Frames / Mockups 14](#_Toc183920027)

[3.5.3 System Architecture 14](#_Toc183920028)

[3.6 System Deliverables 15](#_Toc183920029)

[3.6.1 System Proposal 15](#_Toc183920030)

[3.6.2 System Design Diagram 15](#_Toc183920031)

[3.6.3 Machine Learning Model 16](#_Toc183920032)

[3.6.4 User Interface and Front-end Development 16](#_Toc183920033)

[3.6.5 Testing and Validation 16](#_Toc183920034)

[References 17](#_Toc183920035)

[Gantt Chart. 20](#_Toc183920036)

List Of Figures

[Figure 2.1: Conceptual Framework 8](#_Toc179771519)

[Figure 3.1: kanban board 10](#_Toc179771520)

List Of Abbreviation

Apps -Application

css- cascading stylesheet

ET al-and all

Html- hypertext markup language

JS-JavaScript

ML-Machine Learning

UI -User Interface

UX-User experience

# Introduction

## Background

Recipe recommendation apps have transformed the way individuals approach meal preparation, providing users with personalized recipe suggestions based on available ingredients, dietary preferences, and cooking styles (Pecune et al., 2020). Popular apps like Yummly, Tasty, and AllRecipes have empowered millions of users to explore new recipes and simplify their cooking experience. These platforms utilize algorithms to suggest meals based on user input, offering a range of options for breakfast, lunch, and dinner (Morol et al., 2022).

As people explore a wider range of cuisines, the desire for dishes using exotic ingredients has skyrocketed. Exotic fruits, which are rare fruits, typically grown in tropical or subtropical regions and are less commonly found in everyday grocery stores, include fruits like dragon fruit, passion fruit, lychee, and tamarind (Cornara et al., 2020). These unique fruits offer distinctive flavor profiles, textures, and health benefits, making them ideal ingredients for innovative and adventurous cooking (Spina et al., 2024). Incorporating these fruits into meals often requires specialized knowledge of their culinary uses, which many home cooks find challenging.

Gourmet meals are refined dishes distinguished by their use of rare ingredients, intricate flavors, and advanced preparation techniques such as smoking or vacuum cooking. The term "gourmet" originates from the French word for a connoisseur of fine food and drink, evolving from the 18th-century groumet, meaning a wine-taster renowned for discerning flavors. This expertise in judging wine extended to the art of creating and appreciating exquisite food (Foodie, 2023; Billingsworth, 2024).

However, many users struggle to find accessible recipes that integrate these exotic ingredients in a sophisticated, gourmet manner, particularly for those with diverse culinary interests (Wang, et al., 2021). Although recipe recommendation systems have advanced, current platforms are largely designed for casual home cooking and meal planning, often emphasizing simplicity and convenience over culinary creativity (Neha et al., 2023). As a result, these platforms fail to provide personalized gourmet suggestions for users looking to elevate their cooking with exotic fruits.

To address these limitations, the proposed solution involves the development of a web app that leverages machine learning to provide personalized gourmet recipe suggestions centered around exotic fruits. By analyzing the unique properties of each fruit—such as its flavor profile, texture, and nutritional content—the app will match users with gourmet recipes that suit their preferences. This platform will cater to individuals seeking creative ways to incorporate exotic fruits into gourmet dishes, offering them a more sophisticated and tailored cooking experience.

## Problem Statement

Exotic fruits such as dragon fruit have grown in popularity due to their vibrant colour, unique flavour and nutritional benefits These fruits are mostly used for nutritional value and not for sophistication of dishes (Zaid et al.,2024). Despite their appeal, they are unexplored in common recipe apps such as AllRecipes, which usually focuses on common ingredients and casual cooking. As a result, users especially food connoisseurs, with interest in gourmet recipes used with exotic fruits are left out.

This project proposes the development of a machine learning-based web app designed to address this gap. By leveraging machine learning to analyze exotic fruits’ properties—such as flavor, texture, and nutritional content—the app will provide highly personalized gourmet recipe recommendations. This platform aims to cater to users seeking creative, high-quality ways to incorporate exotic fruits into their cooking repertoire.

## Objectives

### General Objectives

This project aims to develop a machine learning based web application that enhances the culinary experience by offering personalized, gourmet-level recipe suggestions based on exotic fruits.

### Specific Objectives

1. To investigate the current culinary experience of users seeking gourmet recipes.
2. To assess the current recipe recommendation systems.
3. To review the current machine learning techniques used for recommendation systems.
4. To develop a user-friendly, machine learning-based web app that addresses these challenges such as limited integration of exotic fruits in gourmet recipes, lack of personalization in existing platforms, and insufficient accessibility of advanced culinary techniques, thereby enhancing the gourmet recipe suggestion process.
5. To test the platform developed.

## Research Questions

1. What is the current culinary experience of users seeking gourmet recipes?
2. What are the strengths and weaknesses of current recipe recommendation systems?
3. What are the current machine learning techniques used in recommendation systems, and how effective are they?
4. How can a machine learning-based web app be developed to enhance the gourmet recipe suggestion process?
5. How effective is the platform in addressing the identified challenges and improving the user experience?

## Justification For the System.

As the popularity of exotic fruits continues to rise globally (Zaid et al., 2024), there is a gap in knowledge regarding how to incorporate these fruits into gourmet meals. Existing recipe recommendation systems largely focus on common ingredients, often overlooking the potential of exotic fruits (Min et al., 2021). This web app will fill that gap by offering personalized, gourmet recipe suggestions, enabling users to experiment with unfamiliar fruits in creative and exciting ways. Its implementation will be important in fostering culinary innovation and providing users with healthier and more diverse dietary options.

## Scope of the system.

The scope of the system includes its ability to offer curated gourmet recipes based on exotic fruits inputted by users, catering specifically to food connoisseurs—individuals with a refined palate and an appreciation for high-quality culinary experiences. The app leverages a machine learning model to provide personalized recipe suggestions by analyzing the characteristics of the fruits, such as flavor, texture, and sweetness, and matching them to suitable gourmet dishes. Users can further tailor their experience by filtering results based on preferences like cuisine type and dietary restrictions, such as vegan or gluten-free options.

However, the system has limitations. Since the web app is designed primarily for demonstration purposes, the dataset of fruits and recipes is intentionally curated and may be limited in scope, potentially affecting the breadth and precision of recipe recommendations. Additionally, the machine learning model, while functional, may not fully capture all the nuanced culinary variations sought by expert users.

Furthermore, as the app is a prototype, scalability and performance may be restricted, particularly when handling high user volumes or more complex recommendation scenarios.

# Literature Review

## Introduction

This chapter explores the challenges and limitations of recipe recommendation systems powered by machine learning, particularly in delivering diverse and personalized suggestions. Through a review of relevant literature, it identifies gaps in current solutions and proposes a machine learning-based application that creates gourmet recipes centered around exotic fruits. The system is designed to bridge these gaps by enhancing diversity and personalization in recipe recommendations.

### Interactions of users with recipe recommendation apps

Interaction of the app by the user usually begins with inputting specific preferences or parameters such as the food and set filters based on dietary preferences (e.g., vegan, gluten-free) or cuisine type. The system then processes the information using machine learning algorithms—such as content-based filtering or collaborative filtering—to suggest relevant gourmet recipes. These algorithms analyze the characteristics of the inputted fruits, such as flavor profiles, and match them with recipes that align with the user’s preferences. The output is a list of curated recipe suggestions, each with detailed instructions, ingredient lists, and serving sizes.

### How the machine learning and algorithm involved works

Machine learning (ML) techniques and algorithms for recipe recommendation applications are mainly used for personalizing suggestions based on user preferences (Aggarwal, 2020). One is content-based filtering, where the system recommends items (such as recipes) based on the characteristics of the user input. It then matches the attributes of exotic fruits—such as sweetness, texture, or flavor profile—with recipes that contain similar or complementary ingredients. This technique relies on data about the items and user preferences but can suffer from limitations like a lack of diversity in suggestions if users input the same type of data repeatedly (Felfernig et al., 2020).

Another widely used approach is collaborative filtering, which can be applied in two forms: user-based or item-based. User-based collaborative filtering compares a user’s preferences with those of similar users, who have used the app previously, to recommend items that those users have liked. Item-based collaborative filtering, meanwhile, suggests recipes based on similarities between items that the user has already engaged with, rather than comparing users who have used the app previously. The problem with collaborative filtering is can be limited by the cold-start problem, where there is insufficient data for new users or new items.

Other approaches are the hybrid approach, which combine both content-based and collaborative filtering and deep learning algorithms such as convolutional neural networks (CNNs) or recurrent neural networks (RNNs) used to be trained to understand and predict user tastes based on the content of recipes or user behavior patterns, enhancing the recommendation process (Zhang et al., 2020).

### Challenges faced by users when interacting with recipe recommendation apps

As with many recommendation systems, there are challenges. One is inaccurate or irrelevant recommendations, where the system fails to provide suggestions that align with the user's specific preferences or needs due to algorithmic limitations or insufficient data. Users might also encounter difficulties with navigation and user interface (UI) design, where the app’s layout is not intuitive when inputting and filtering. Additionally, limited customization options can hinder users from tailoring their search results to their specific dietary requirements or cuisine preferences, reducing the effectiveness of the app

Another challenge is lack of diverse food choices in the database as they focus on popular ingredients. As a result, experimentation especially with gourmet recipes via exotic fruits challenging.

## Technique

The technique for developing recipe recommendation apps typically involves a combination of machine learning techniques and algorithmic strategies to provide personalized suggestions. One of the key methods is content-based filtering, where the system recommends recipes by analyzing the ingredients and characteristics of user-selected dishes, then matching those with similar recipes (Bangale et al., 2022). For instance, if a user inputs an exotic fruit like dragon fruit, the system will suggest recipes that either feature the fruit or have similar flavor profiles. Collaborative filtering is another common approach, which leverages user behavior data to recommend recipes based on the preferences of others with similar tastes (Sharma et al., 2023).

To enhance accuracy, many modern systems employ a hybrid model, combining both content-based and collaborative filtering techniques (Widayanti et al., 2023). Additionally, the app's recommendation algorithms are trained on large datasets consisting of ingredients, cooking methods, and user feedback, with machine learning tools refining the personalization process over time. Validation and optimization of the recommendation system are carried out through testing methods like cross-validation and A/B testing to ensure the algorithm’s effectiveness in providing relevant recipe suggestions.

The app’s frontend is usually developed by JavaScript frameworks like react.js or vue.js (Lazuardy et al., 2022). The database used is mongo dB, a NoSQL type, due to ease of malleability of data (Lim et al., 2019).

## Related Works

### Tasty

It is a mobile-based cooking app developed by Buzzfeed (Blackburn, et al., 2020). It is known for its engaging recipe videos and step-by-step cooking guides. The app recommends recipes through machine learning specifically, user-based filtering where past history of ingredients and dietary preferences is used to recommend new dishes. Through deep learning, the app analyzes user interactions, such as likes, shares, and views, to improve recipe suggestions over time and computer vision to tag video recipes automatically, making it easier to search for specific ingredients or cuisines. The target audience is mainly casual cooks or novice.

### Forks Over Knives

It is a web and mobile based app whose target audience is health-conscious users looking for plant-based, nutritious meals. It uses machine learning via collaborative filtering and content-based filtering algorithms to recommend recipes based on past user selections and ingredient preferences (Graham et al., 2023).

### Yummly

It is a widely popular recipe recommendation platform that operates both on web and mobile devices. It uses a combination of machine learning techniques such as collaborative filtering and content-based filtering (Kumar et al., 2022). The app's recommendation engine analyzes various data points such as user behavior, ratings, ingredients, and cooking methods to tailor recipes to individual users as in the case of content-based filtering (Kumar et al., 2022). In addition, it employs collaborative-filtering by analyzing cooking history and preference of users (Kumar et al., 2022). By employing collaborative filtering and content-based filtering algorithms, Yummly continuously improves its recommendations based on user feedback and patterns. Its target audience range from chefs to novice cooks (Ang, 2021).

### Cookbooks

Cookbooks have long been the traditional source for learning gourmet recipes. Often passed down as family heirlooms, these cookbooks carry cherished, time-honored recipes through generations (Notaker, 2022). Others are published by renowned chefs, such as Gordon Ramsay and Marco Pierre White, and are available through major publishers and libraries (Lengyel, 2024). These cookbooks may feature both contemporary gourmet dishes and ancient, secret recipes that only a few are privy to.

To find a specific recipe, users typically need to sift through the book, paying close attention to details such as the freshness and uniqueness of ingredients, as well as the intricate, step-by-step cooking instructions. Once the recipe is located, the user proceeds with the cooking process, carefully measuring ingredients, chopping, sautéing, or marinating as instructed. As they follow the recipe, they may pause to take notes, adjusting ingredients to suit personal taste or available supplies (Niewiadomska-Flis et al., 2024). This method allows for a hands-on, immersive cooking experience, but it can also be time-consuming as users navigate through the book or refer to their handwritten notes to ensure every step is followed precisely.

## Gaps in Related works

Exotic fruits are often overlooked in many mainstream recipe recommendation systems. This is due to limited availability and unfamiliarity of these fruits in certain regions, as well as the lack of robust databases that include them. Most recipe cater to common, high consumed fruits worldwide such as apples, bananas, and berries. Moreover, the dataset on exotic fruits is limited as most recipe apps are geared towards generic recommendations.

## Proposed System

The proposed system is a web-based application designed to suggest gourmet recipes based on the input of exotic fruits from users, primarily food connoisseurs. By utilizing machine learning algorithms, the system will analyze the characteristics of the fruits provided by users, such as their flavor profile, texture, and nutritional properties, to recommend gourmet recipes that can creatively incorporate them

Users will have the ability to filter recipes based on dietary preferences (e.g., vegan, gluten-free) or cuisine types (e.g., French, Asian, Caribbean), and each recipe will include detailed preparation instructions, ingredients, and serving suggestions.

A study by De Cesare et al. (2018) highlights the growing interest in global cuisines, but acknowledges that recipe platforms do not sufficiently cater to the inclusion of exotic ingredients in their datasets. Similarly, in the book The Flavor Bible by Page and Dornenburg (2008), the authors emphasize the importance of flavor pairing, which is a critical aspect missing when exotic fruits are underrepresented in food recommendation systems. Therefore, this system would fulfill these needs.

## Conceptual Framework



Figure 2:1 Conceptual Framework

The system starts with the user entering the fruit and preferences in the search box of the web app displayed by the PC. This is then transmitted to the server. Upon Receiving the request, the server processes the data by passing it to the machine learning model embedded in the server. The machine learning model analyzes the fruit characteristics such as flavour profile, texture in relation to user’s preferences. This is done by algorithm such as content-based filtering or item-based filtering. The gourmet recipe is then generated and fetched from the database. The database then sends the recipe back to the server, which then sends it to the PC where the user sees the output.

# Methodology

## Introduction

This chapter outlines the overall approach taken for the development of the gourmet recipe suggestion web application. It describes the selected methodology, the rationale behind its choice, and the various stages of system analysis, design, and development. The chapter begins with an introduction to the methodology, followed by a discussion on the development approach, the justification for using this approach, and detailed insights into system analysis and design. Finally, it concludes by specifying the expected system deliverables.

### Methodology to be used.

Object-Oriented Analysis and Design (OOAD) is particularly suitable for the gourmet recipe suggestion web application because it allows for a modular and scalable architecture that mirrors the real-world relationships between the various entities involved, such as exotic fruits, recipes, and users. This methodology enables the encapsulation of data and behavior within distinct objects, facilitating easy maintenance and future enhancements as new features or datasets are added (Maulana, et al., 2024). Furthermore, its emphasis on reusability and flexibility supports the integration of machine learning algorithms, ensuring that the system can evolve dynamically based on user interactions and feedback while maintaining high performance and functionality.

## Development approach Methodology to be used

The methodology chosen would be Kanban-Driven Incremental Development methodology (Damij et al., 2021). This is a hybrid of Kanban and incremental methodology.

The phases are as follows:



Figure 3.1: Kanban board

### Backlog (To-Do Phase)

The Backlog phase is where all potential features and tasks are gathered and listed for the web app. These features include the ability for users to input exotic fruits, recipe filtering options, and machine learning-powered recipe recommendations. For this web app, increments are identified as distinct modules, such as the user interface (UI) for fruit input, recipe display logic, and integration of machine learning algorithms for recipe personalization.

### In Progress (Development Phase)

Once tasks are pulled from the Backlog, they enter the In Progress phase, where active development occurs. This phase focuses on building the app incrementally, with each increment representing a fully functional module. For instance, the first increment could involve developing the UI that allows users to input exotic fruits and see basic recipe results.

Subsequent increments could involve adding recipe filtering options (e.g., cuisine type or dietary restrictions) and integrating machine learning to offer personalized recipe suggestions. By breaking down development into these smaller, manageable increments, the process becomes more organized and allows for faster progress while maintaining focus on essential features.

### Review (Testing and Feedback Phase)

In the Review phase, each increment undergoes thorough testing to ensure that it functions as intended. For example, after the fruit input module is developed, it is tested to confirm that the app correctly accepts fruit entries and returns recipe suggestions. During this phase, any bugs or issues are identified and fixed before the next increment begins.

The feedback gathered during this phase is crucial for refining the app. The testing process also allows for the integration of user feedback (if available), helping ensure the app meets expectations. In the context of a class demo, this phase is essential for ensuring the app functions smoothly during presentation.

### Completed (Deployment Phase)

Once an increment passes testing, it moves into the Completed phase. For this web app, each completed module adds a layer of functionality. At this stage, the fruit input module, recipe filtering options, and machine learning algorithms are integrated and fully operational. This ensures that, by the end of the development process, the entire app is complete and ready for demonstration.

## Justification of the Kanban-Driven Incremental Development Methodology

The Kanban-Driven Incremental Development Methodology is an effective approach for building the gourmet recipe suggestion web app. By combining the Kanban framework with incremental development, the app can be developed in manageable phases, each one building on the last. This methodology ensures that core features are completed and fully functional in time for the class demonstration, while providing flexibility and a clear path to project completion (Senapathi et al., 2021).

## System Analysis

### Use Case Diagram

A use case diagram captures the functional requirements of the system by showing the interactions between users (actors) and the system (use cases) (Buzaid, et al., 2022). This diagram helps clarify what the system should do from the user’s perspective. In the gourmet recipe app, the main actors could be the "User" and possibly an "Admin" (who manages the database of fruits and recipes). Use cases might include "Input fruit," "Search recipes," "Filter by cuisine," and "View recipe details." This diagram would demonstrate how a user interacts with the system, such as how they enter a fruit to receive recipe suggestions or how they filter the suggestions by dietary preference or cuisine type.

### Class Diagram

A class diagram is a this is a visual representation of classes, methods and attributes, and their interactions for the purpose to depict the system. It defines the structure of the system by showing how objects interact with one another and how data is organized (Abdelnabi, et al., 2021). In the gourmet recipe suggestion web app, a class diagram would include key entities such as "User," "Fruit," "Recipe," and possibly "Ingredient." For example, the "Fruit" class might have attributes like name, flavor profile, and origin, while the "Recipe" class would have methods for retrieving and suggesting recipes based on fruit input. Relationships such as association between a "User" and "Recipe" (i.e., a user selects or saves a recipe) or inheritance where "Fruit" might be a subclass of a general "Ingredient" class could also be illustrated.

### Sequence Diagram

A sequence diagram illustrates the order in which objects in the system interact with one another. It shows how a process is carried out over time by detailing the messages passed between objects (Alvin, et al., 2021). In this web app, a sequence diagram could show the process flow when a user inputs a fruit and receives recipe suggestions. For example, the user inputs the fruit into the system, which then communicates with the recipe database to find matching recipes. The system then returns a list of recipes to the user, completing the interaction. This helps in understanding the timing and sequence of operations between the app's components like the user interface, database, and recipe engine.

### Activity Diagram

An activity diagram represents the flow of activities or processes within the system, illustrating the steps required to complete a task. It provides a visual representation of workflows and business logic (Elmansouri et al., 2021). For the gourmet recipe app, an activity diagram could model the user’s interaction when searching for a recipe. The flow might start with the user selecting an exotic fruit, followed by the system querying the database for matching recipes, allowing the user to filter the results, and finally displaying the selected recipe. This diagram helps to visualize user navigation through the app and the flow of data.

### State Diagram

A state diagram depicts the various states an object can be in and how it transitions from one state to another based on events or actions. This is useful for modeling objects that have a defined lifecycle or behavior in the system (Koç et al., 2021). In this project, a state diagram could be used to represent the "Recipe Suggestion" process. For example, the "Recipe" entity might move through states such as "Pending," where the user is inputting the fruit; "Processing," where the system is retrieving and filtering the recipes; and "Suggested," where a list of recommendations is presented to the user. The state diagram provides clarity on how the system behaves and transitions during user interaction.

## System Designs

### Database Schema

It is a visual or tabular representation of the database structure, defining how data will be stored, organized, and related by outlining in detail the tables, fields, relationships between tables, primary keys, and foreign keys. For the project concerned, key entities like "Fruits," "Recipes," "Users," and "Ingredients would be described in the schema. Each table would have attributes, such as the "Fruit" table containing columns like fruit name, flavor profile, and category. The purpose of this overall is to ensure efficient organization of data for quick retrieval, data integrity, facilitating the implementation of queries to match fruit entries with recipes, store user preferences, and ensure the app runs efficiently. The database schema will be designed using figma.

### Wire Frames / Mockups

These are blueprints of the user interface (UI) layout and structure pertaining to the frontend of the application. The use of components such as buttons, text boxes etc. would be used on webpages to show the layout of the fruit input form, the recipe suggestion page, filter options, login and sign up. The main aim is planning the user experience (UX) by outlining the app’s flow and navigation structure, ensuring that all necessary elements are present and properly arranged before actual development begins (Chen, et al., 2020).

### System Architecture

It is a high-level visual representation of the overall system, showing the components, their interactions, and how they integrate with external systems. It describes the structure of the web app, including the front-end (UI), back-end (server logic), database, and any third-party services such as machine learning APIs for recipe recommendation. For this project, the system architecture would outline the relationships between the user interface, the web server (handling business logic), the database (managing data), and any external machine learning models used for recipe suggestions. The purpose is to provide a clear understanding of how the various parts of the system work together such as identifying communication paths, data flow, and potential bottlenecks, ensuring a cohesive and efficient design that can be scaled and maintained.

## System Deliverables

This section entails a comprehensive outline of what the project aims to deliver, including the final system and its components. It encapsulates all the major outputs that the project will produce to meet its objectives, ensuring the system's functionality, usability, and performance align with the defined requirements. The deliverables entail the following:

### System Proposal

This is a document that entails the project’s main objectives by It includes the purpose of the system, its intended users (e.g., food enthusiasts, home chefs, and culinary professionals), and how it will solve an existing gap (helping users explore gourmet recipes with unique fruits). The proposal defines the scope of the app, such as offering recipe suggestions based on inputted fruits, filtering options for cuisine and dietary preferences, and leveraging machine learning for personalized recommendations. Furthermore, background, literature review of current system and the methodologies employed to make the system, to make a case of developing the system.

### System Design Diagram

These are visual representation of the system’s structure and operation to collectively ensure a clear, cohesive design of the web app’s functionality and structure. The key diagrams from Object-Oriented Analysis and Design (OOAD) will be utilized to structure and clarify the web app’s design. The Class Diagram will define key entities like "User," "Fruit," and "Recipe," detailing their attributes and relationships. A Use Case Diagram will outline how users interact with the app, such as inputting fruits and receiving recipe suggestions. The Sequence Diagram will model the flow of interactions between the user interface, the machine learning algorithm, and the recipe database when a user searches for a recipe. An Activity Diagram will represent the step-by-step process of searching for and filtering recipes, while a State Diagram will track the lifecycle of recipe suggestions. Additionally, Wireframes will illustrate the user interface layout, showing how users will input data, view results, and navigate through the app. The wireframe will be drawn using figma.

### Machine Learning Model

A key deliverable of the system will be the implementation of a machine learning model, which powers the recipe suggestions based on fruit characteristics. This model will be trained on the dataset of fruits and gourmet recipes, ensuring that it delivers relevant and personalized recipe recommendations. This model can be developed using content-based filtering techniques to match users' fruit input with the most suitable recipes. The machine learning used will be ML.Net which is based in C# language.

### **User Interface and Front-end Development**

Another important deliverable will be the development of the web app’s user interface. Based on the wireframes, the front-end should be intuitive and easy to navigate. Users should be able to input fruits, explore recipe suggestions, and apply filters seamlessly ensuring a smooth user experience (UX). The frontend will be created using ASP.NET, which allows coding for c# with html, CSS and JavaScript, with SQL capabilities for the backend and ML.NET plugin

### Testing and Validation

This is final deliverable which entails unit testing for individual components (e.g., recipe search functionality, database queries) and system testing to evaluate the overall performance, user experience, and accuracy of the machine learning model. The testing will be done via postman.

# **References**

Abdelnabi, A, E., Maatuk, M, A., Hagal, & Mohammed. (2021). Generating uml class diagram from natural language requirements: A survey of approaches and techniques. In *2021 IEEE 1st International Maghreb Meeting of the Conference on Sciences and Techniques of Automatic Control and Computer Engineering MI-STA* (pp. 288-293). IEEE.

Aggarwal, C. C. (2020). *Recommender Systems: The Textbook.* Springer International Publishing.

Alvin, Chris, Peterson, Brian, Mukhopadhyay, & Supratik. (2021). Static generation of UML sequence diagrams. *International Journal on Software Tools for Technology Transfer, 23*, 31-53.

Ang, Y. H. (2021). Food recipe related social platform.

Bangale, S., Haspe, A., Khemani, B., & Malave, S. (2022, May). Recipe recommendation system using content-based filtering. *In Proceedings of the International Conference on Innovative Computing & Communication*.

Billingsworth, L. (2024, February 4). *What Is The Meaning Of Gourmet Food?* From Gourmet Gullet: https://gourmetgullet.com/what-is-the-meaning-of-gourmet-food/

Blackburn, Hontanosas, K. G., Nahas, J. a., Bajaj, K. a., Thompson, K. a., Monaco, R. a., . . . Everett. (2020). Food foraging online: Exploring how we choose which recipes to search and share. *First Monday*.

Buzaid, Faisal, Albalooshi, Fawzi, Elmedany, & Wael. (2022). The Use of UML Diagrams to Enhance Dynamic Feature Location Techniques. In *2022 International Conference on Innovation and Intelligence for Informatics, Computing, and Technologies (3ICT)* (pp. 285-292). IEEE.

Chen, Jieshan, Chen, C., Xing, Zhenchang, Xia, . . . Jinshui. (2020). Wireframe-based UI design search through image autoencoder. *ACM Transactions on Software Engineering and Methodology (TOSEM), 29*(3), 1-31.

Cornara, Xiao, L. a., Smeriglio, J. a., Trombetta, A. a., Burlando, D. a., & Bruno. (2020). Emerging exotic fruits: New functional foods in the European market. *Efood, 1*(2), 126-139.

Damij, Nadja, & Talib. (2021). An approach to optimizing Kanban board workflow and shortening the project management plan. *IEEE Transactions on Engineering Management*.

De Cesare, M. e. (2018). Culinary Diversity and the Representation of Exotic Ingredients in Digital Recipe Platforms. *Journal of Food and Culture.*

Elmansouri, R., Meghzili, S., & Chaoui, A. (2021). A UML 2.0 activity diagrams/csp integrated approach for modeling and verification of software systems. *Computer Science, , 22*(2).

Felfernig, A., Friedrich, G., Jannach, D., & Zanker, M. (2020). *Developing Constraint-based Recommender Systems.* Springer.

Foodie, E. L. (2023, July 27). *Gourmet Cuisine: An Exquisite Journey into Culinary Artistry*. From Eat Live Foodie: https://www.eatlivefoodie.com/art-of-gourmet-cuisine/

Graham, C., Scherer, M. a., Keen, C. a., & Carl, M. (2023). An Analysis of the nutritional adequacy of mass-marketed vegan recipes. *Cureus, 15*(4).

Koç, H., Erdoğan, A. M., Barjakly, Y., & Peker, S. (2021). UML diagrams in software engineering research: a systematic literature review. *Proceedings, 74*(1), 13.

Kumar, A. a., Pachaury, B. a., Patel, U. a., Shah, P. a., & Parth. (2022). Social commerce platform for food enthusiasts with integrated recipe recommendation using machine learning. *Information and Communication Technology for Competitive Strategies (ICTCS 2021) ICT: Applications and Social Interfaces*, pp. 515-523.

Lazuardy, S., Fariz, M., & Anggraini, D. (2022). Modern front end web architectures with react. js and next. js. *Research Journal of Advanced Engineering and Science, 7*(1), 132-141.

Lengyel, A. (2024). *Celebrity Chefs and the Social Construction of Taste in Contemporary British Society.* London: University of West London.

Lim, W. Y., Lim, H. B., & Cho, H. (2019). Recipe recommendation using machine learning and MongoDB. Journal of Database Management. *30*(1), 54-67.

Maulana, Mustafa, R., Husna, Miftahul, Sugiarti, & Yuni. (2024). Object-Oriented Analysis in Software Engineering: A Systematic Review of the Literature. *Informatics and Software Engineering, 2*(2), 52-60.

Min, S., & Oh, Y. (2021). Implementation of Recipe Recommendation System Using Ingredients Combination Analysis based on Recipe Data. *Journal of Korea Multimedia Society, 24*(8), pp. 1114-1121.

Morol, M. K., Rokon, M. S., Hasan, I. B., Saif, A. M., Khan, R. H., & Das, S. S. (2022, March). Food recipe recommendation based on ingredients detection using deep learning. *Proceedings of the 2nd International Conference on Computing Advancements*, pp. 191-198.

Neha, K., Sanjan, P., Hariharan, S., Namitha, S., Jyoshna, A., & Prasad, A. B. (2023, August). Food prediction based on recipe using machine learning algorithms. *In 2023 Second International Conference on Augmented Intelligence and Sustainable Systems (ICAISS)*, pp. 411-416.

Niewiadomska-Flis, Ursula, & Westerfelhaus, R. (2024). Curating Culinary Culture: The Rhetorical Function of Cookbooks and Their Paratexts. *Res Rhetorica, 11*(3), 119-144.

Notaker, H. (2022). *A History Of Cookbooks: From Kitchen to Page over Seven Centuries.* California Studies in Food and Culture.

Page, K., & Dornenburg, A. (2008). *The Flavor Bible.* Little, Brown and Company.

Pecune, Florian, Callebert, Lucile, Marsella, & Stacy. (2020). A Recommender System for Healthy and Personalized Recipes Recommendations. In *HealthRecSys@ RecSys* (pp. 15-20).

Senapathi, M., & Drury-Grogan, M. L. (2021). Systems thinking approach to implementing kanban: A case study. *Journal of Software: Evolution and Process, 33*(4), e2322.

Sharma, K., Mandapati, K., Pattekar, M., Kumar, K., & Srinivasa, G. (2023, June). Food recommendation system based on collaborative filtering and taste profiling. *In 2023 3rd International Conference on Intelligent Technologies (CONIT)*, pp. 1-6.

Spina, D., Zanchini, R., Hamam, M., Di Vita, G., Chinnici, G., Raimondo, M., & ... & D'Amico, M. (2024). Unveiling the exotic fascination of tropical fruits: the role of food values on consumer behavior towards mangoes. *Journal of Agriculture and Food Research, 15, 100956*.

Spina, Daniela, Zanchini, Raffaele, Hamam, Manal, . . . Mario. (2024). Unveiling the exotic fascination of tropical fruits: the role of food values on consumer behavior towards mangoes. *Journal of Agriculture and Food Research, 15*, 100956.

Wang, W., Duan, L. Y., Jiang, H., Jing, P., Song, X., & Nie, L. (2021). Market2Dish: health-aware food recommendation. *ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM) 17(1)*, 1-19.

Widayanti, R., Chakim, M., Lukita, C., Rahardja, U., & Lutfiani, N. (2023). Improving recommender systems using hybrid techniques of collaborative filtering and content-based filtering. *Journal of Applied Data Sciences, 4*(3), pp. 289-302.

Zaid, A., Verma, N., Chandra, V., Lamo, K., Negi, P., Dessai, s., & Govind, B. (2024, October). The Role of Exotic Fruits in Modern Diets: Health Benefits and Nutritional Value. *Journal of Advances in Biology & Biotechnology*, pp. 1468-1474.

Zhang, S., Yao, L., Sun, A., & Tay, Y. (2020). *Deep Learning Based Recommender System: A Survey and New Perspectives.* ACM Computing Surveys (CSUR).

Gantt Chart.

