

Software Engineering (ECE 452) - Spring 2019
Group #3

Restaurant Automation Codename Adam

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Contributions Breakdown

Everyone contributed equally to report #1.

Section 1: Customer Problem Statement

1.1: Problem Statement

Restaurant automation is a daunting task, as there are many variables to consider in the automation process. Moreover, it is important to maintain a balance between efficiency and hospitality as most customers associate restaurants with their ambience as opposed to mechanized efficiency. Many restaurants nowadays have started to automate their tasks, such as Panera Bread and TGIF, by streamlining the ordering and payment processes by employing tablets with specialized apps. Spyce, a restaurant in Boston, has automated its cooking process by replacing human chefs with a robot [4]. However, even the owners of Spyce seek to maintain the human touch by attempting to tailor the experience for each customer.

For this reason our project aims to automate basic tasks that customers, waiting staff and chefs have to perform in restaurants, without outright replacing them, in order to maintain the human touch that the restaurant experience depends on. This, in turn, will decrease the time it takes from customers coming in and placing their order to actually being served their food, resulting into better dining experience. Additionally, it will help the restaurant owners manage their business better through detailed statistics and analysis of trends. It will provide a way to easily see all the placed orders as well as a way to predict the amount of ingredients that will be needed for any given day, (inferred from historical data). This allows the restaurant owners to dramatically cut down the leftovers and shape their menu accordingly to what sells best. Moreover, our project will improve customer experience by recommending meals.

While the proposed solution requires additional investment in the form of electronic devices for customers and servers, as of 2018 lower-end tablets running Android operating system can be purchased for under \$50 dollars, especially in larger quantities. As such, this is well within the realm of financial feasibility for medium and even small, family owned restaurants. Although our prototype is tailored towards Android operating systems, it can be implemented on the iOS operating system if restaurants do not mind paying more.

Problem: Helping customers decide on a meal to eat

A common problem that customers face when going to eat a restaurants, whether they have visited the restaurant before or not, is deciding on what food to eat. This problem is often worsened by menus with food items with very “foreign” sounding names or unfamiliar menus in general. Such problems can discourage customers from visiting the same restaurant, so we find that assisting customers with choosing meals will cause them to maintain their relationship with our establishment. As a result, this will cause our customer base to increase over time.

The Codename Adam Solution:

We seek to solve this problem by implementing a meal recommendation system, which will be enhanced by using responses from the review system. In order to implement the recommendation system, the user will be given the choice to take a short quiz before ordering their meal. This quiz will ask questions about their meal

preferences (if they want a meal with cheese, rice, meat, etc.) to recommend a list of appropriate meals. This quiz component will incorporate active learning by taking the user's choices (what meal they select from the given list) into account for future recommendations. Likewise, the user will be allowed to "favorite" meals on the application, which will also be taken into account for future meal recommendations. After a user finishes their meal, they will be given a short questionnaire to rate the meal and restaurant service. This responses from this short questionnaire (the review system) will also be taken into account when recommending meals to future customers. If the customer returns, we can further streamline the ordering process, using an account system with facial recognition. During this procedure, all the customer needs to do is take a seat and look at the camera, avoiding any inconveniences such as user login. Of course, to avoid any concerns about data collection and invasion of privacy users are informed of their information being stored and can opt out of this feature at any time.

Problem: Providing customers with efficient and careful service

With the advancement of internet technologies, customers want information delivered to their screens instantly. For restaurants in particular, they would like to see today's menu, reserve a table or even order food in a matter of seconds, without ever leaving their homes or talking to people. Along with customer service, restaurants have consider their customers' dietary concerns. This includes taking religious dietary laws (such as Halal and Kosher) and fad diets (Keto and Vegan) into account. Moreover, as food allergies have become more prevalent in today's era, it has become more important for restaurants to be vigilant with their food preparation efforts.

The Codename Adam Solution:

Codename Adam provides an ecosystem of websites and mobile apps that allow customers to interact with restaurants remotely and effortlessly. Checking today's specials, getting food recommendations, reserving a table and making an order can now be done in a matter of seconds. In order for the restaurant staff to be able to keep up with the features offered online, we will also offer apps for servers and chefs to increase their productivity by being able to receive orders instantly and be notified immediately when an order is done cooking and is ready to be served. Furthermore, the app specialized for the waiting staff will provide information about the meals, such as ingredients used, calorie information, and any possible allergy warnings. Likewise, the restaurant website (with admin privileges and the ingredient prediction system) will help restaurant owners decrease operating costs and increase profits.

Problem: Make server spend their time more efficiently

A server has a lot of things to do when they are working. For example, they need to serve for new-coming customers and stand by them to listen to their decisions on meals, they need to bring a finished meal from chef to a customer who is waiting, they need to go helping those customers who is calling a server for some specific questions. They have a lot things to do in their work, so an efficient way to use their time is really desired so that all customers can enjoy their time by being fully served.

The Codename Adam Solution:

Actually, there are some unnecessary actions that can be avoided by making our application more advanced. For example, if we can allow the customers to order their food on the table app, the time servers used to spend on recording customers' decisions can be saved. If we can allow customers to order food online instead of making phone calls, then the time servers use to talk to customers on phone can be saved. If we can allow customers to use the application to write down their specifications on each meal, then the overhead servers spend in transmitting the information from customers to chefs can be saved. With time saved, servers can spend more time on those customers who request a server calling so they can be helped at once.

Problem: Maximizing profits and streamlining process for the Chef

The kitchen is the engine of a restaurant. Every customer's order must pass through the kitchen, which means that the efficiency and quality at which the kitchen operates heavily impacts the performance of the restaurant itself. As a result, it is in the restaurant's best interest to promote the efficiency of its chefs and the quality of its ingredients and to reduce wastage in its kitchen. If this can be accomplished, chefs will have more time and fresher ingredients, allowing them to produce a larger quantity of meals of higher quality, not only improving the customer's dining experience, but also increasing the restaurant's profit potential.

The Codename Adam Solution:

Codename Adam's ingredient prediction system helps to solve many of these problems that restaurants face. Based off of records of which menu items were ordered on the same day of the week in previous weeks, the ingredient prediction system will calculate an estimated amount of each ingredient that will be required on that specific day. This will allow chefs to determine how much of each ingredient to prepare for the day's dishes, reducing food wastage, preventing chefs from wasting time preparing unnecessary ingredients, and ensuring that dishes use only the freshest of ingredients. In the beginning, the chef may want to prepare a little more than what is estimated, but over time, the estimate should become more refined and more accurate, as outliers are identified and pruned from the estimation. This will be accomplished by performing the RANSAC algorithm on the amount of ingredients needed for the k most recent weeks. The estimate may also be refined by trends in dish reviews and favorites and pending reservations. An extension of this feature may further divide the ingredient prediction by time of day, to maximize the freshness of ingredients and efficient use of the chefs' time.

What makes Codename Adam a better solution for restaurant automation?

Codename Adam is a better solution for restaurant automation because unlike applications created in previous years, it provides a way for restaurants to plan their future spending through the ingredient prediction system and enhances the customer experience through the meal recommendation system. Our project is an improvement over Why W8 [1], the Fall 2018 solution to restaurant automation, because it utilizes their innovations (rating and favorites system) to create a meal recommendation

system. Along with providing a list of meals frequently eaten at a restaurant, registered customers will benefit from receiving recommendations based on their personal preferences even if the menu changes. Moreover, our project is an improvement over FoodEZ [2], the Spring 2015 solution to restaurant automation, because it streamlines the meal payment process even more by providing different payment options through the customer application and table application. This reduces the time waiting staff spends on accounting for meals paid using different methods.

1.2: Glossary of Terms

Customer app: a software that customers can download on their mobile devices and use to order food from the restaurant

Table app: a software that is built inside every table devices, so dine-in customers can use it to order food, request service and pay the bill

Server app: a software that every server needs to download on their mobile devices and it will help alert everything associated with the demand of their service

Chef app: a software that every chef needs to see the list of ordered meals they need to cook

RANSAC: Random Sample Consensus, an iterative approach to a linear regression model that ignores outliers

Linear Regression: a statistical method that aids in summarizing and studying relationships between two variables

Levenberg-Marquardt Nonlinear Least Squares Algorithm: refines the parameters iteratively using the least squares method and the Taylor series expansion

Content-Based Filtering: recommends items to users based on their profile (recorded interests, preferences, etc.)

Collaborative Filtering: makes predictions of a user's behavior based on preference information collected from many other users

Cosine Similarity: measures similarity between two dense (non-zero) vectors by measuring the angle between them

Gradient: stores partial derivative information about a multivariable function

Jacobian Matrix: matrix of all first order partial derivatives of a vector-valued function

Section 2: System Requirements

2.1: Functional Requirements

2.1.1: Customer/Table Apps

Identifier	Priority (Higher number indicates higher priority)	Requirement
REQ-01	5	For customer and table app, users should be able to browse the most up to date menu
REQ-02	1	For customer and table app users should be able take a quiz to get meal recommendations
REQ-03	3	For customer and table app unregistered users should be able to register
REQ-04	1	For customer and table app all registered users should be able to see meal suggestions based on their previous dining habits
REQ-05	3	For customer app, registered users should be able to order food online, either to be delivered or to be picked up.
REQ-06	3	For customer app, registered users should be able to reserve a table at the restaurant.
REQ-07	3	The app should use facial detection to find people in front of it. Once a face is detected that takes up a significant portion of the screen, the app will use facial recognition to uniquely identify the user and log them in. If login fails, give the user the opportunity to login or register.
REQ-08	5	For table app, all users should be able to make an order and pay for it by entering their credit card information on the device, or in person.
REQ-09	5	For table app, customer should be able to request assistance.

2.1.2: Server App

Identifier	Priority (Higher number indicates higher priority)	Requirement
REQ-10	4	For server app, all users have to login before using the app
REQ-11	5	For server app, all registered users should be notified when a customer requires assistance
REQ-12	5	For server app, all registered users should be able to manually place an order for a customer
REQ-13	5	For server app, all registered users should be notified when an order has been completed and should be served to the customer

2.1.3: Chef App

Identifier	Priority (Higher number indicates higher priority)	Requirement
REQ-14	5	All users should be able to view a dynamically updated queue of orders.
REQ-15	4	All users should be able to mark an order as fulfilled after it has been prepared, which would send a notification to the server app.
REQ-16	4	For the chef app, when an order is completed, the required ingredients will automatically be deducted from the ingredient inventory.

2.1.4: Restaurant Website

Identifier	Priority (Higher number indicates higher priority)	Requirement
REQ-17	5	The website should contain information about the

		menu and most popular food items.
REQ-18	4	Customers should be able to make reservations or take out/delivery orders (if applicable) from a page on the website.
REQ-19	3	The website should allow users to sign in to their accounts in order to use the meal recommendation feature.
REQ-20	4	The website admin page should display relevant statistics, such as earnings, most popular foods and ingredient usage.
REQ-21	4	The website admin page should predict future dish popularity and ingredient consumption based on order history of the past few weeks.
REQ-22	1	The website admin page should allow the owner to modify the menu, change prices, and enable/disable features.

2.2: Nonfunctional Requirements:

2.2.1: Customer/Table App

Identifier	Priority (Higher number indicates higher priority)	Requirement
REQ-23	1	The user should not need to wake the table device for ordering, it should be done automatically when they sit down at the table.
REQ-24	3	All users should be able to manually log in when any part of the facial recognition system is not available or has failed
REQ-25	4	The user should not suffer noticeable delay when they're scrolling through the menu and click on items

2.2.2: Server App

Identifier	Priority (Higher number indicates)	Requirement
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	higher priority	
REQ-26	5	The app should be easy to navigate and use, since waiters have to serve multiple customers as quickly as possible.
REQ-27	3	This application should be modular so that any new updates can be made easily in case new functionality is added
REQ-28	3	The application should be designed to be as clean as possible so that some non-necessary or repeated information or activity can be avoided.

2.2.3: Chef App

Identifier	Priority (Higher number indicates higher priority)	Requirement
REQ-29	5	This application should be intuitive to use
REQ-30	4	The application should be designed to be as clean as possible so that some non-necessary or repeated information or activity can be avoided.
REQ-31	1	The application should allow the chef to do most actions in 2 clicks or less, since oftentimes they will have dirty hands.

2.2.4: Website

Identifier	Priority (Higher number indicates higher priority)	Requirement
REQ-32	5	The website should be connected to the same database that the ecosystem of apps is connected to.
REQ-33	5	The website admin page should only be accessible by a user that has logged in with admin credentials.
REQ-34	4	The website should expose API endpoints to be used by the apps

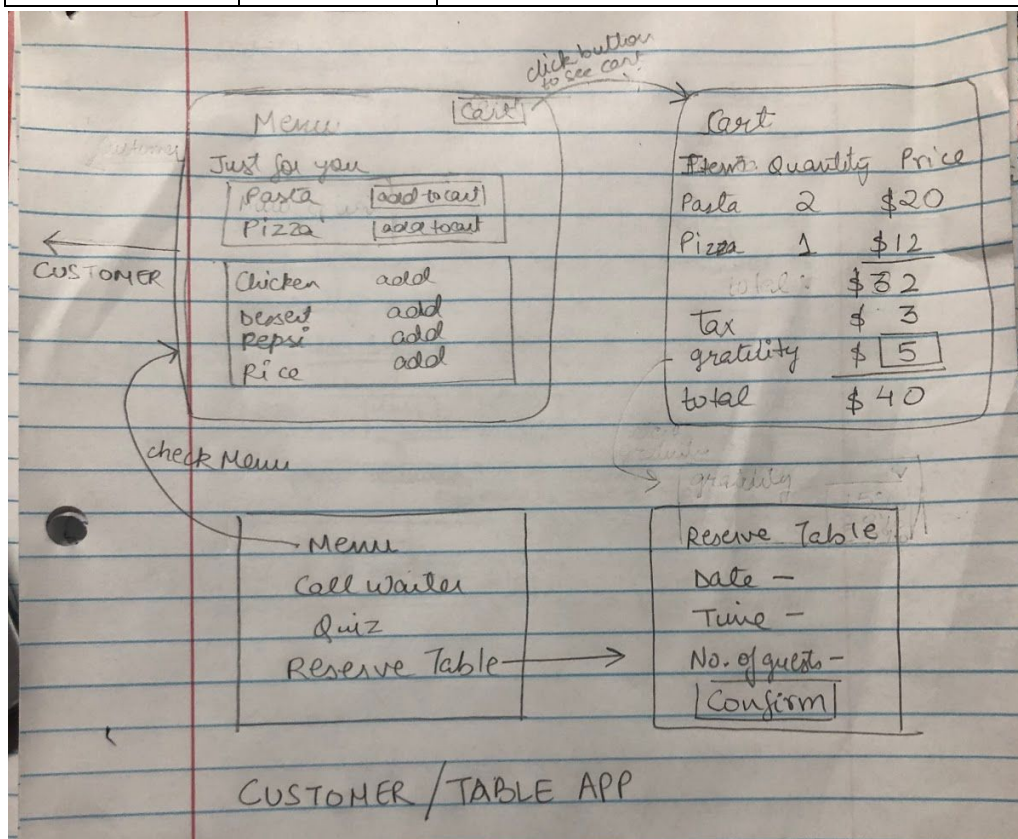
REQ-35	5	The popularity of dishes should reasonably follow a trend based on the popularity in the past. The ingredient prediction should take into account the demand of ingredients in the past.
REQ-36	4	There may be outliers on certain holidays or other occurrences that we don't want to take into account when looking at overall trends.
REQ-37	5	Since the amount of customers will change every day, the ingredient prediction should take into account the day of the week.
REQ-38	3	While the popularity of dishes will follow a trend, over longer periods of time, the popularity may change drastically. To take this into account, the data from the few most recent weeks should be weighted harder.
REQ-39	2	The ingredient prediction should also take into account the time of day.
REQ-40	5	The website should communicate with the data system via the same REST API as the mobile apps.

2.3: UI Requirements

2.3.1: Customer/Table App

Identifier	Priority (Higher number indicates higher priority)	Requirement
REQ-41	5	Customer/Table Apps should have a menu tab with a list of dishes that can be ordered.
REQ-42	4	The menu tab should have recommended dish at the top and should be marked as either "Recommended for you" or "Just for you"
REQ-43	5	The menu tab should have a "Cart" button, which would take the user to the cart page
REQ-44	5	The cart page should display all items currently in the cart, their quantities, price per item, subtotal, tax, gratuity, delivery costs (if ordering online), and total

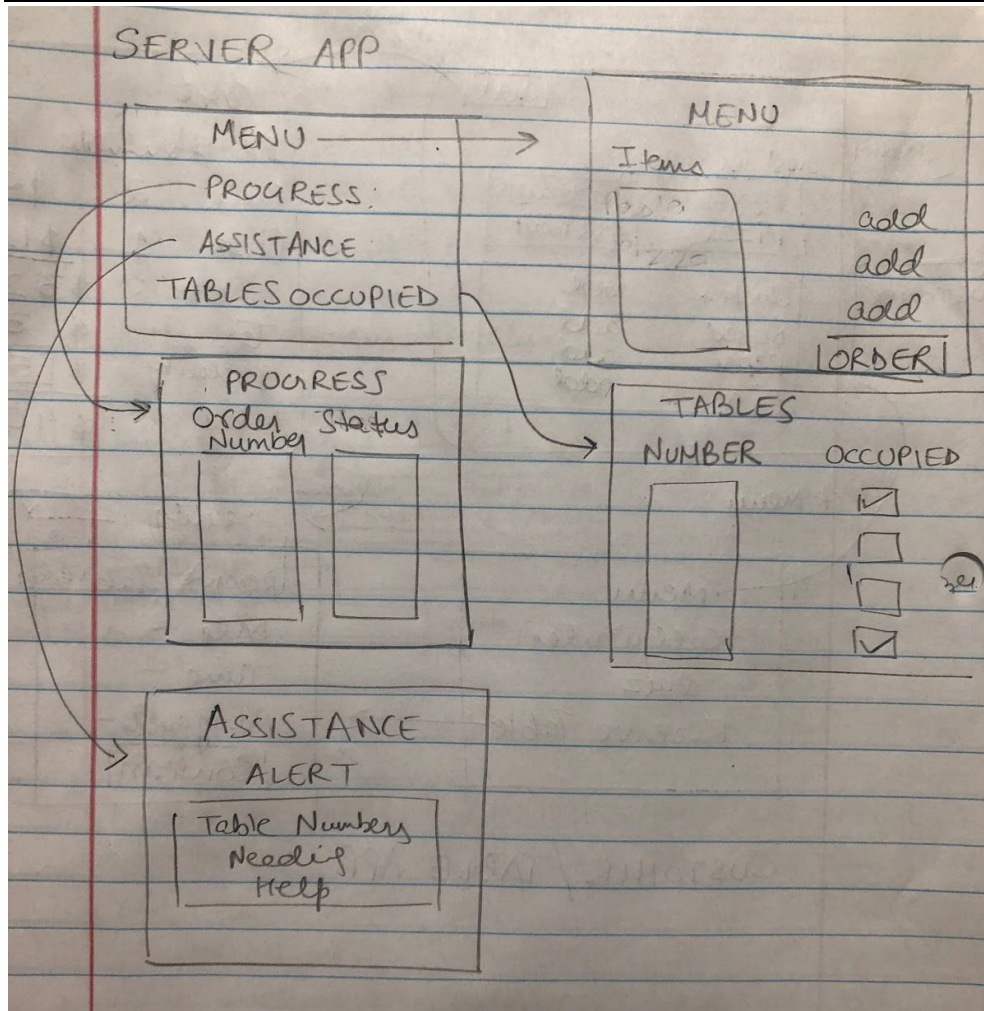
		cost.
REQ-45	2	The cart page should allow the user to enter a custom tip amount via input textbox.
REQ-46	5	The menu tab of the Table App should have a “Call Waiter” button
REQ-47	2	Customer/Table Apps should have a “Quiz” tab
REQ-48	3	The Customer App should have a table reservation page, which would have a “Date/Time” field and a “Confirm” button



2.3.2: Server App

Identifier	Priority (Higher number indicates higher priority)	Requirement
REQ-49	5	Server app will be similar to customer menu so the waiter may place orders for the customer. See REQ-42

REQ-50	3	Server will have access to see progress of food orders so in order to prepare for food delivery.
REQ-51	5	An alert to get the server's attention when needed
REQ-52	2	A visual model to see which tables are assigned to the server that is logged in.



2.3.3: Chef App

Identifier	Priority (Higher number indicates higher priority)	Requirement
REQ-53	5	Chef App should provide a list of all orders. Each item in this list should contain as much information as possible about each order, to minimize the amount of

		scrolling and button-pressing.
REQ-54	5	Every item in the list of orders should have a button to mark order as complete.

The image shows a hand-drawn sketch of a 'CHEF APP' interface. It features a table titled 'ORDERS' with three columns: 'Number', 'Items', and 'Status'. The table contains two rows of data. The first row has '1' in the 'Number' column, 'a)' in the 'Items' column, and 'COMPLETE' in the 'Status' column. The second row has '2' in the 'Number' column, 'a)' in the 'Items' column, and 'PENDING' in the 'Status' column. The sketch is drawn on lined paper with a red vertical margin line on the left.

Number	Items	Status
1	a)	COMPLETE
2	a)	PENDING

2.3.4: Website

Identifier	Priority (Higher number indicates higher priority)	Requirement
REQ-55	5	Website should have a navbar with links to the menu and ordering pages.
REQ-56	5	Website should have login button where admin can access admin console.
REQ-57	3	Admin page should contain line graphs of recent revenue, dish popularity, and ingredient consumption trends.
REQ-58	2	Admin page graphs should have a bar graph to represent the dish popularity or ingredient consumption prediction.

WEBSITE

LOGIN CUSTOMER

EMAIL

PASSWORD

LOGIN ADMIN

ID

PASSWORD

MENU
ORDER

MENU

JUST for YOU

Items

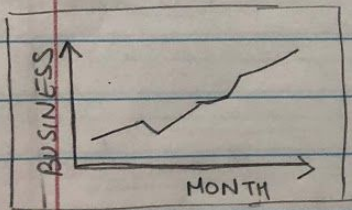
ORDER

Items

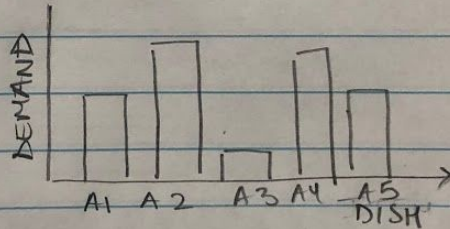
ORDER

ADMIN

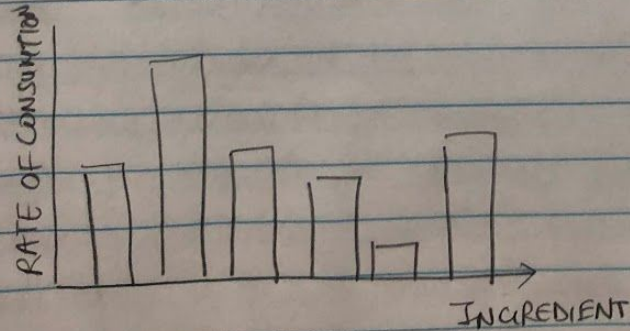
REVENUE



DISH POPULATIVITY



INGREDIENT CONSUMPTION



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Section 3: Functional Requirements Specification

3.1: Stakeholders

The following are the stakeholders who will have the most interest to design and run the system.

- Restaurant owner
- Employees i.e Owner, Chef, Waiter, etc
- Investors who want to explore new business mode

3.2: Actors & Goals

Table 3.2.1 Initiating Actors

Actor	Role	Goal
Customer	The customer who pays the money for delicious food and good service. They would use the application to take quizzes and get recommendations from the system.	The goal of the customer is to enjoy the service and food provided by the restaurant. They can choose the food that best suits their appetite.
Owner	The owner uses the application to monitor the restaurant running status to make sure the restaurant is running efficiently.	The goal of the owner is to maximize the profit of running the restaurant by using the application and to increase customer satisfaction .
Chef	The chef decides the taste of food they wait for the orders from the customers and cooks the food in customers' specific request.	The goal of the chef is to prepare meals on the order queue and make the food that suit customer's appetite.
Waiter	The waiter is the person who assists dine-in customers in taking the quiz, making the order and bringing the food to their table.	The goal of the waiter is to provide the wonderful service to customers, such as help customers make orders, bring food to their table and pay the bills.

Table 3.2.2 Participating Actors

Actor	Goal
Database	The database record the quizzes result, table selection, customer's order, and inventory

3.3: Use Cases

3.3.1: Customer/Table Apps

Actor	Actor's Goal	Use Case Name
Customer	To order food, either to be delivered, served or picked up.	OrderFood (UC-1)
Customer	To be offered meal suggestions.	Suggest (UC-2)

Customer	To log in via facial recognition software.	Recognize (UC-11)
Customer	To create an account with the restaurant.	Register (UC-12)

3.3.2: Server App

Actor	Actor's Goal	Use Case Name
Waiter	To be notified when an order has been prepared by the chef and should be delivered.	OrderComplete (UC-3)
Waiter	To be notified when a customer needs assistance.	AssistanceNeeded (UC-4)
Waiter	To be able to place customer's order manually.	OrderFood (UC-1)
Waiter	To create an account with the restaurant.	Register (UC-12)

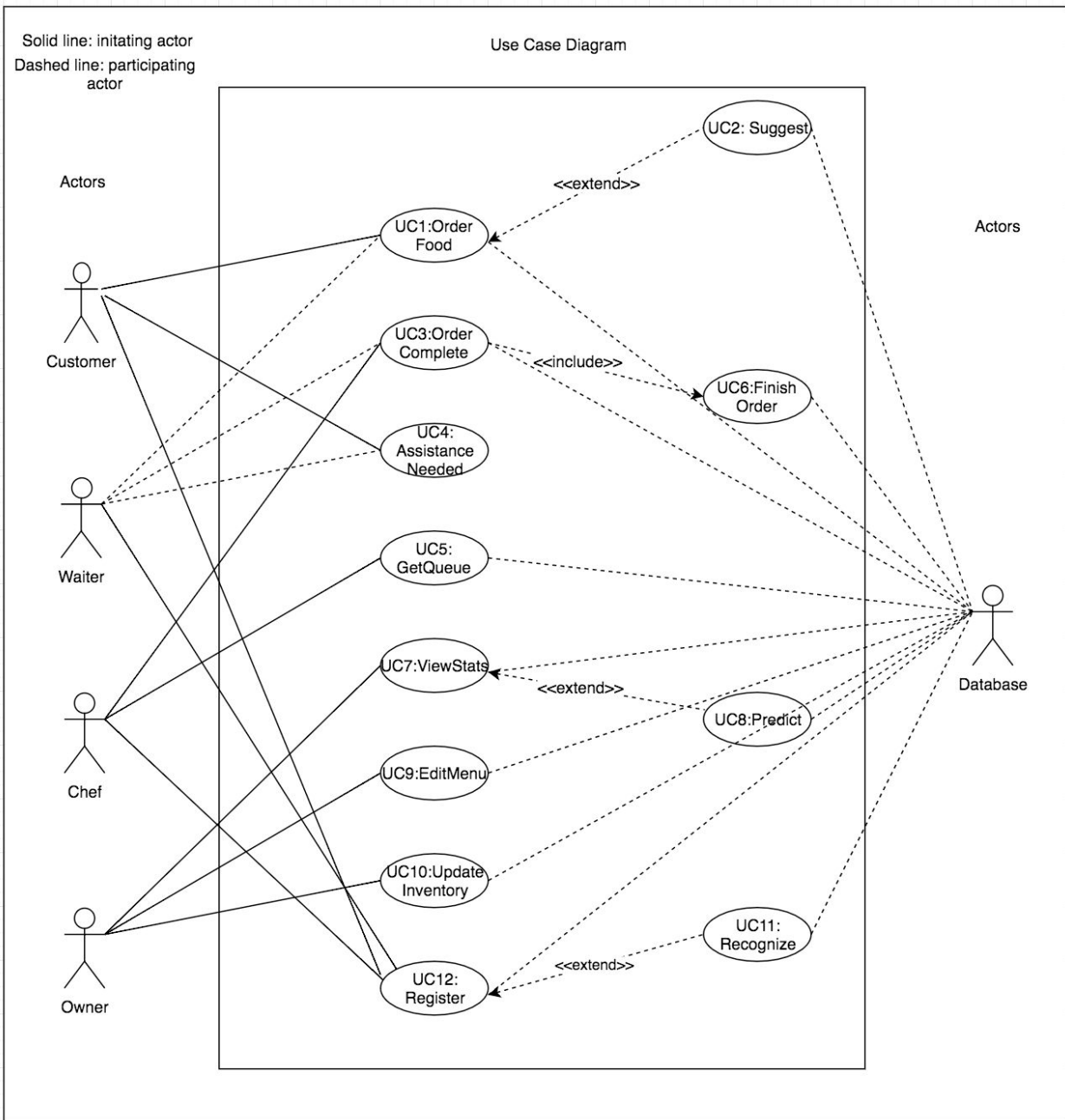
3.3.3: Chef App

Actor	Actor's Goal	Use Case Name
Chef	To be able to see the list of current orders.	GetQueue (UC-5)
Chef	To mark a dish as complete and to update ingredient inventory automatically.	FinishOrder (UC-6)
Chef	To create an account with the restaurant.	Register (UC-12)

3.3.4: Restaurant Website

Actor	Actor's Goal	Use Case Name
Customer	To order food, either to be delivered, served or picked up.	OrderFood (UC-1)
Customer	To create an account with the restaurant.	Register (UC-12)
Owner	To view statistics about restaurant performance.	ViewStats (UC-7)
Owner	To predict trends in dish popularity and dish consumption.	Predict (UC-8)
Owner	To modify the menu and prices.	EditMenu (UC-9)
Owner	To update ingredient inventory.	UpdateInventory (UC-10)

3.4: Use Case Diagram



3.5: Traceability Matrix

Req	PW	UC-1	UC-2	UC-3	UC-4	UC-5	UC-6	UC-7	UC-8	UC-9	UC-10	UC-11	UC-12
REQ-01	5	X											
REQ-02	1		X										
REQ-03	3												X
REQ-04	1		X										
REQ-05	3	X											
REQ-06	3	X											
REQ-07	3											X	
REQ-08	5	X											
REQ-09	5				X								
REQ-10	4												X
REQ-11	5				X								
REQ-12	5				X								
REQ-13	5			X									
REQ-14	5					X							
REQ-15	4			X			X						
REQ-16	4						X						
REQ-17	5	X											
REQ-18	4	X											
REQ-19	3		X										
REQ-20	4							X					
REQ-21	4								X				
REQ-22	1									X	X		
Max PW		5	3	5	5	5	4	4	4	1	1	3	4
Total PW		25	5	9	15	5	8	4	4	1	1	3	7

3.6: Fully-Dressed Descriptions

UC-1: Order Food
Related Requirements: REQ-01, REQ-05, REQ-06, REQ-08, REQ-17, REQ-18
Initiating Actor: Customer
Actor's goal: To order food, either to be delivered, served or picked
Participating Actors: Waiter, Database
Preconditions: <ol style="list-style-type: none">1. Customer successfully sets up the application on the table or his/her own mobile device and logs in2. The system displays a menu that users can look up
Postconditions: <ol style="list-style-type: none">1. The order has been stored into database2. One of waiters should have the order displayed on their application
Flow of Events for Main Success Scenario: <ul style="list-style-type: none">→ 1. Customers open the application by clicking the icon on their phone and select “menu”→ 2. Customers add the food they like into orders by clicking the “+” icon appear under each food description→ 3. Customers click the “confirm” button← 4. The system automatically brings customers to the payment page→ 5. Customers enter their payment information and click “confirm” button to verify the payment← 6. The system signals database to store this order and notify one waiter to add the order← 7. The system brings customers to the ending page and signals “Order Completed!”

UC-3: OrderComplete
Related Requirements: REQ-13, REQ-15
Initiating Actor: Chef
Actor's goal: To notify the waiter that order is completed and should be delivered
Participating Actors: Waiter, Database

Preconditions: <ol style="list-style-type: none"> 1. Food of the order is fully prepared 2. The chef app displays the button “Order Complete”
Postconditions: The waiter is coming to get the food and going to deliver it
Flow of Events for Main Success Scenario: <ul style="list-style-type: none"> → 1. Chef click the button “Order Complete” on his chef app ← 2. The system displays a notification on the waiter’s app → 3. Waiter gets ready to come to pick up the food

UC-4: Assistance Needed
Related Requirements: REQ-9, REQ-11,REQ-12
Initiating Actor: Customers
Actor’s goal: To notify the waiter that assistance is needed
Participating Actors: Waiter, Database
Preconditions: Customers open the table app and see the “call server” button
Postconditions: The waiter is coming to the table whose table app has called him/her
Flow of Events for Main Success Scenario: <ul style="list-style-type: none"> → 1. Customers click the button “call waiter” on the table app ← 2. The system sends the table id from table app to the database ← 3. The system takes the table id from database to server app → 4. The waiter sees customers of that table need help → 5. The waiter gets ready to go to the table

UC-6: FinishOrder
Related Requirements: REQ-15,REQ-16
Initiating Actor: Chef
Actor’s goal: To mark a dish as complete and to update ingredient inventory automatically
Participating Actors: Database
Preconditions: Chef should be notified that customers have successfully receive

their food after the “order complete” UC

Postconditions:

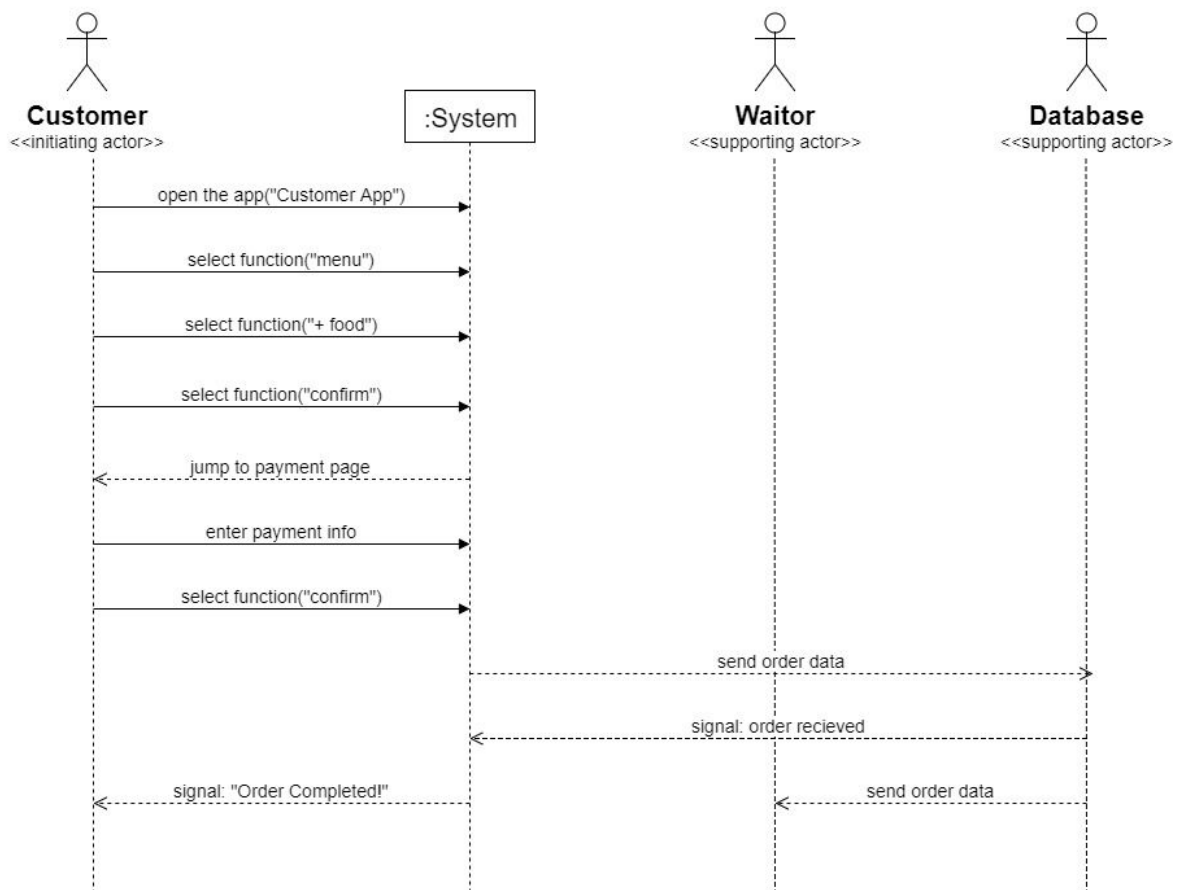
1. The order should be fully deleted from the database and remove from both the server and chef app
2. The information of ingredient inventory should be updated in the database

Flow of Events for Main Success Scenario:

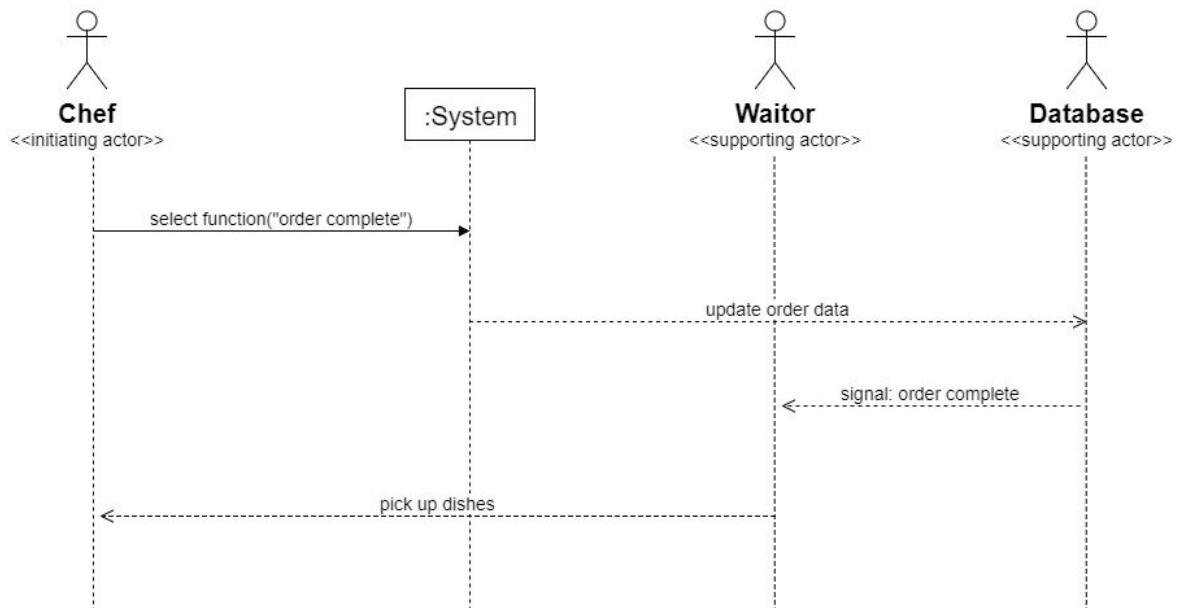
- 1. Chef click the “FinishOrder” button appearing below the order on the chef app
- ← 2. The system sends the order id and request from chef app to the database to delete the order information
- ← 3. The system updates the information of ingredient inventory in the database by referring to the order information
- ← 4. The system displays a removal in both server and chef app

3.7: System Sequence Diagrams

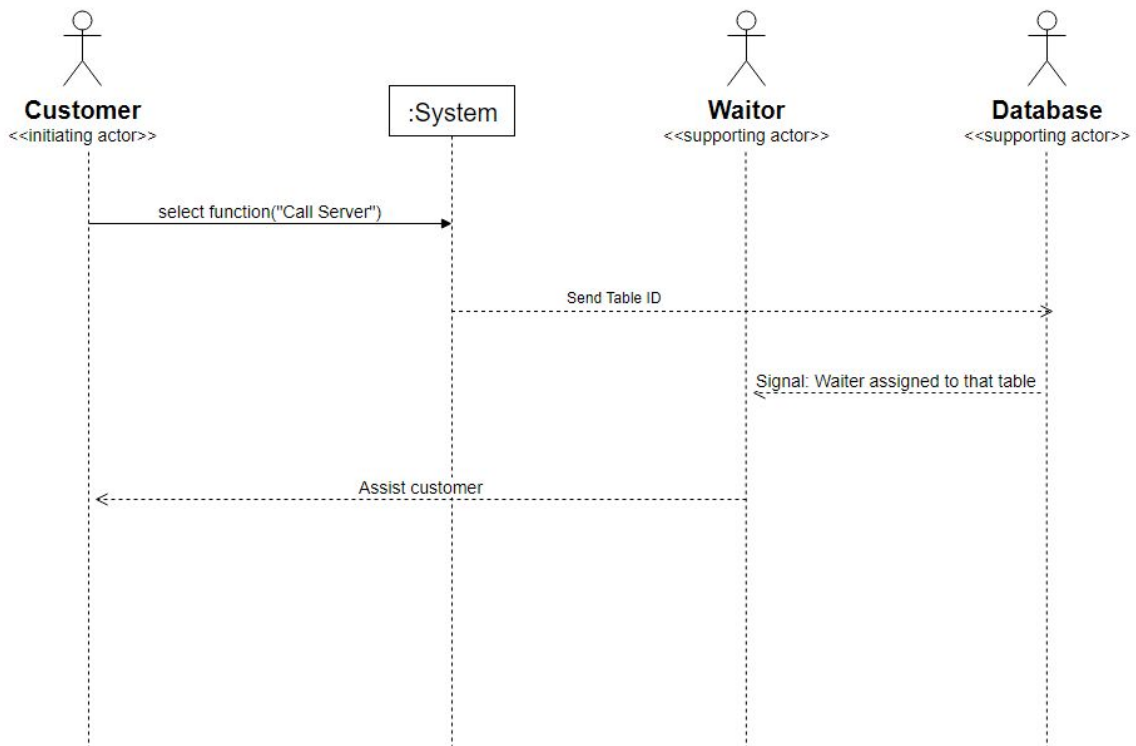
**User Case 1:
Order Food**



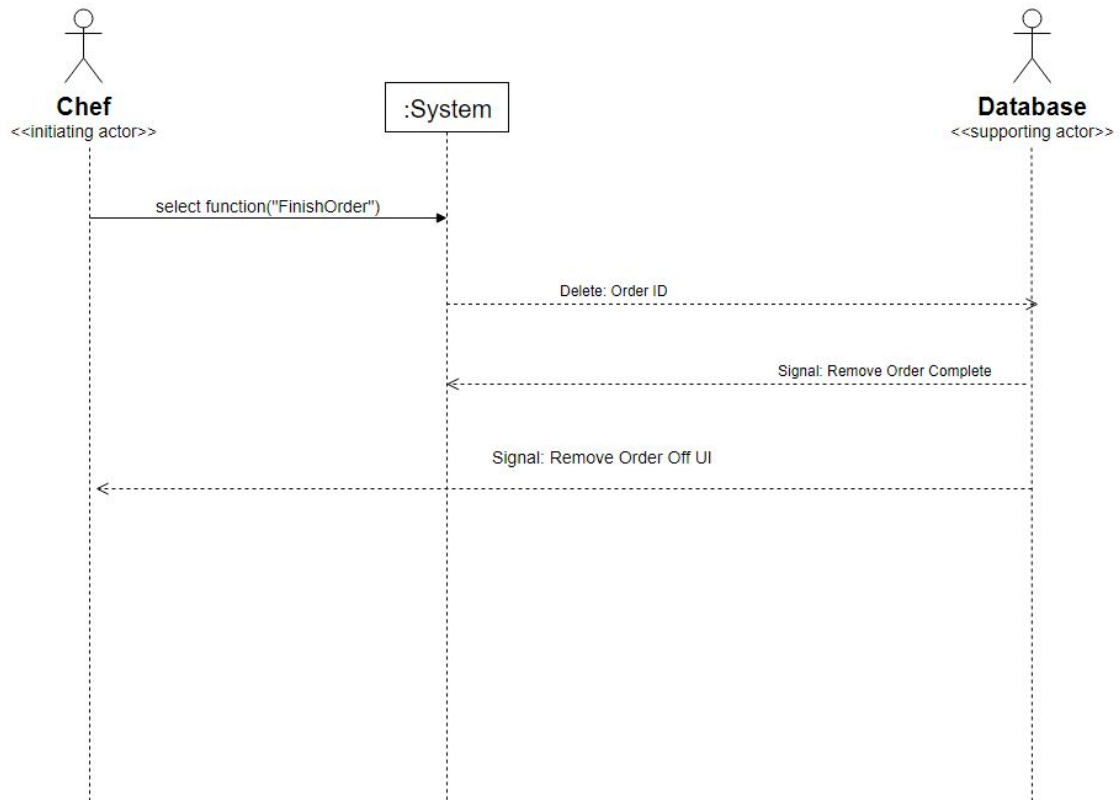
User Case 3: Order Complete



User Case 4: Assistance Needed



× × ×
× **User Case 6:** × × ×
× **Finish Order** × × ×
× × ×



Section 4: User Interface Specification

4.1: Preliminary Design


4.1.1: UC-1: Order Food

Customer App Screens

Menu

Help

Cart




Pizza

\$3.99

Pizza description long

+




Hamburger

\$8.99

Burger description long

+




Pasta

\$7.99

Pasta description long

+



Steak

\$9.99

Steak description long

+

Confirm

Payment Page

Help

Cart(3)

Items in Cart:

Food Item	Quantity	Subtotal
Pizza	2	6.99
Hamburger	1	8.99

Taxes:

3.00

Gratuuity:

0.00

Total:

18.98

Select Payment Option:

☒ Credit

Enter Credit Card #

Enter Credit Card Pin

☐ Debit

Submit Payment

Payment Page

Help

Cart

Order Complete!

Thank you for submitting your order!

A confirmation email has been sent to your inbox.

Upon arrival at the restaurant, a waiter will be ready to give you your order.

Please let us know if you have any questions in the meantime at 1-800-555-5555!

Steps to Take:

1. Customer goes to menu screen on the customer app.
2. Customer selects the '+' button located in each menu item on the list to add to their cart.
3. After customer selects all of the food items they want, they press the 'confirm' button on the bottom of the menu page.
4. Customer is directed to the payment page, where they can view their order information. On the bottom of the screen, customer selects their desired payment option and enters their information.
5. After entering all of their information, customer presses 'submit payment' button.
6. Customer is directed to order completion page on the app once payment is submitted and processed. In the meantime, the restaurant database is updated and a waiter is notified of the order.

4.1.2: UC-3: Order Complete
Chef App Screen

Order Screen		
<div>Help Logout</div>		
Order Details:		
Food Item	Quantity	Complete?
Pizza	2	<input checked="" type="checkbox"/>
Hamburger	1	<input checked="" type="checkbox"/>
Pasta	4	<input checked="" type="checkbox"/>
Appetizer	5	<input checked="" type="checkbox"/>
<div>Order Complete</div>		

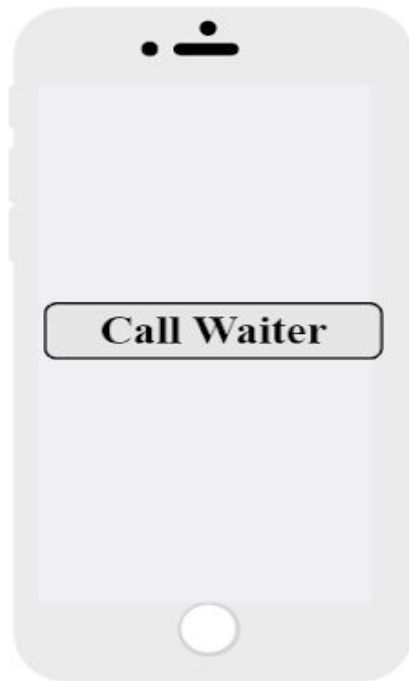
Waiter App Screen

Dashboard
<div>Help Logout</div>
New Notification!
Order #34 for Table#12 is ready to be served to the customers.
Other information about Waiter App goes here

Steps to Take:

1. The chef checks off all order items that were prepared.
2. After all items are checked off, the chef presses the 'order complete' button.
3. Once an order is completed, a waiter receives a notification on the waiter app that informs them of the order that was completed and to what table it should be taken to.

4.1.3: UC-4: Assistance Needed Customer app



Waiter Screen

A smartphone screen displaying a table with three columns: Table number, Customer Name, and Assistance provided. The table contains four rows of data.

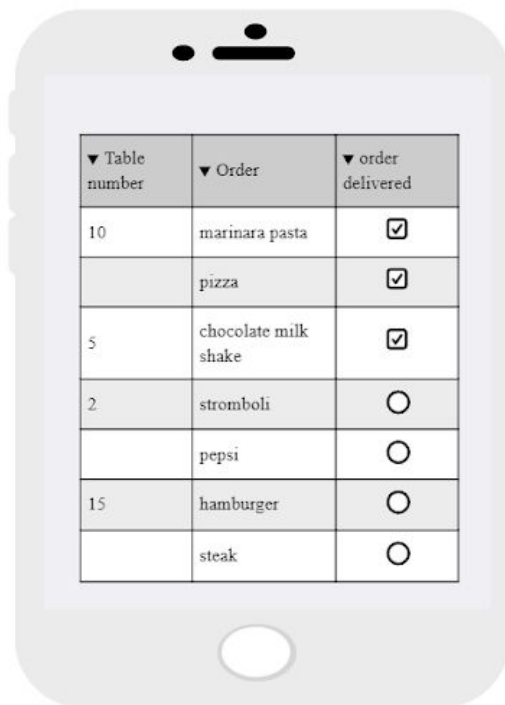
▼ Table number	▼ Customer Name	▼ Assistance provided
10	Dan	<input checked="" type="checkbox"/>
5	Alisha	<input checked="" type="checkbox"/>
2	Chris	<input type="checkbox"/>
15	Sam	<input type="checkbox"/>

Steps to Take:

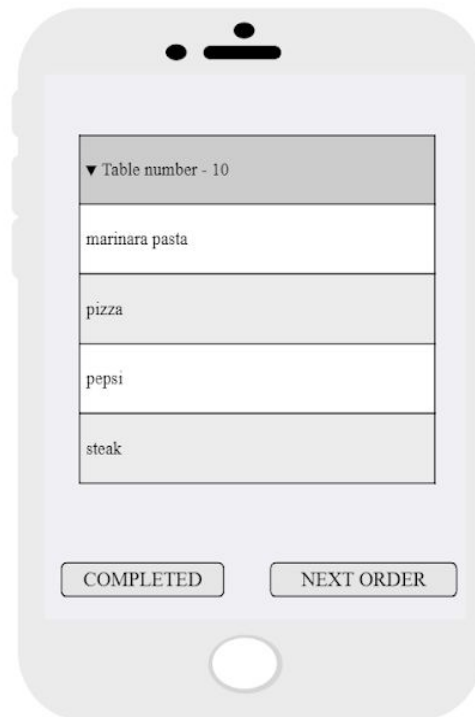
1. The customer presses the 'CALL WAITER' option when they need assistance on their application
2. The person's details who needs assistance pops up on waiters app
3. The waiter checks of the name of the person who has already been assisted and the waiter moves on to the next person.

4.1.4: UC-6: Finish Order

Waiter App



Chef App



Steps to Take:

1. Chef's screen shows the ongoing order and once the chef completes the order he presses the 'COMPLETE' button and then the 'NEXT' button for the next order he wants to prepare
2. The waiter takes over the order and tick marks the orders he has delivered
3. The orders completed at both ends are removed from the queue.

4.2: User Effort Estimation

4.2.1: UC-1: Order Food

Scenario 1: Customer knows exactly what to order

In this scenario, the customer would press the '+' button n times for all n items that they want order. Depending on the size of the menu, the customer would have to use at least 1 keystrokes in order to press the '+' button next to the menu items they want to order. Then the customer will have to press the 'confirm' button. Once directed to the payment page on the customer app, the customer will have to select the appropriate radio button for their desired payment choice. Then they will have to manually enter their payment information. Once all information is entered, the customer will press the 'submit payment' button. This will direct them to the order completion screen.

Number of button presses: n (menu items) + 3 (other buttons)

Number of keystrokes: $\geq 1 + 19$ (for entering in credit card number)

Fraction of user interface navigation: $4/(n + 23)$

Fraction of clerical data entry: $19/(n + 23)$

Scenario 2: Customer wants to edit their order before paying

In this scenario, the customer will press a 'edit order' button on the first payment page (this button will be added to the app although it's not on the mock-up). Once directed back to the menu screen, the user will press the '+' button m items or the '-' button (this will appear next to items already added to cart) k times. Then they will press the 'confirm' button once more. Depending on the length of menu, they customer will have to use at least 1 keystrokes while adding and deleting menu items. These are the only additional steps the customer will have to take in this scenario.

Number of button presses: $n + m + k + 4$

Number of keystrokes: $\geq 2 + 19$

Fraction of user interface navigation: $6/(n + m + k + 25)$

Fraction of clerical data entry: $19/(n + m + k + 25)$

4.2.2: UC-3: Order Complete

Scenario 1: Chef marks all food items as completed and confirms order completion

In this scenario, the chef will use n keystrokes to mark all n menu items as complete. Afterwards, the chef will press the 'order complete' button. Then the waiter will receive a notification on their app and will have to use 1 keystroke to view the notification.

Number of button presses: 1

Number of keystrokes: $n + 1$

Fraction of user interface navigation: $2/(n + 2)$

Fraction of clerical data entry: $n/(n + 2)$

Scenario 2: Chef confirms order completion before marking all food items as complete

In this scenario, the chef forgot to mark all menu items as complete. So, after pressing the 'order complete' button, the chef will receive a notification with an error message about why the order completion was not processed. Then, the chef will have use 1 keystroke to open the notification. After reading the notification, the chef will mark the remaining menu items as complete and press the 'order complete' button again. Then the waiter will receive a notification on their app and will have to use 1 keystroke to view the notification.

Number of button presses: 2

Number of keystrokes: $n + 2$

Fraction of user interface navigation: $4/(n + 4)$

Fraction of clerical user data entry: $n/(n + 4)$

4.2.3: UC-3: Assistance needed

*Customer clicks the 'call waiter' button to address the waiter for assistance**

In this scenario, the customer will press the 'call waiter' button. Then the waiter will receive a notification and will use 1 keystroke to view the notification. After providing assistance, the waiter will check 'assistance provided' checkbox next to the

table number to mark that he has offered assistance to the given table. Then the customer's assistant request is waved off automatically.

Number of button presses: 1

Number of keystrokes: 2

Fraction of user interface navigation: $1/3$

Fraction of clerical user data entry: $2/3$

*Due to the nature of this use case, it only has one possible scenario

4.2.4: UC-6: Finish Order

Scenario 1: Chef marks all food items as completed and confirms order completion

In this scenario, the chef will use n keystrokes to mark all n items ordered as complete. Afterwards, the chef will press the 'complete' button and then the 'next' button to move on to the next order. Then the waiter will receive a notification on their app and will have to use 2 keystroke one to view the notification and one to mark the order completed.

Number of button presses: 2

Number of keystrokes: $n + 2$

Fraction of user interface navigation: $2/(n + 4)$

Fraction of clerical user data entry: $(n + 2)/(n + 4)$

Scenario 2: Chef confirms order completion before marking all food items as complete

In this scenario, the chef forgot to mark all menu items as complete. So, after pressing the 'order complete' button, the chef will receive a notification with an error message about why the order completion was not processed. Then, the chef will have use 1 keystroke to open the notification. After reading the notification, the chef will mark the remaining n menu items as complete and press the 'order complete' button again. Then the waiter will receive a notification on their app and will have to use 1 keystroke to view the notification

Number of button presses: 2

Number of keystrokes: $n + 2$

Fraction of user interface navigation: $2/(n + 4)$

Fraction of clerical user data entry: $(n + 2)/(n + 4)$

Section 5: Domain Analysis

5.1: Domain Model

5.1.1: Concept Definitions

Responsibility	Type	Concept
R-01: Takes customer's orders and propagates them down the chain: from customer to chef to waiter and back to the customer.	D	Manager
R-02: Knows of user accounts and stores their previous	K	UserAccount

orders.		
R-03: Displays most up to date menu.	K	Menu
R-04: Uses customers' previous orders to recommend them a meal similar to what they liked.	D	MealRecommend
R-05: System manages the database.	K	Database
R-06: Provides a simple API to access the data from the database.	D	Database
R-07: Knows how many ingredients are available.	K	Ingredients
R-08: Updates the list of available ingredients when an order is placed.	D	Ingredients
R-09: Allows restaurant owner to update the menu.	D	Menu
R-10: Notifies waiters when their assistance is required.	D	WaiterNeeded
R-11: Tracks order status.	K	Manager
R-12: Accepts online payments.	D	Payment
R-13: Administers a quiz and matches the response to possible meal suggestions.	D	MealRecommend
R-14: Queues received order.	D	OrderQueue

5.1.2: Association Definitions

Concept Pair	Association Description	Association Name
Menu <-> Database	Get the menu from the database/update the menu in the database.	QueryDB
UserAccount <-> MealRecommend	Uses user's past orders to come up with meal recommendations.	UserRecommend
Manager <-> WaiterNeeded	Lets the waiter know if customer needs assistance or an order has been completed.	NotifyWaiter

UserAccount <->Database	Fetches user information.	QueryDB
Ingredients <-> Database	Fetches/Updated available ingredients	QueryDB
Payment <-> Manager	Allows customer to pay for the order they just placed.	OrderPayment
Manager <-> OrderQueue	Add a placed order to the orders queue.	AddOrder
Manager <-> Ingredients	Automatically update available ingredients when an order has been placed	UpdateIngredients

5.1.3: Attribute Definitions

Concept	Attribute	Attribute Description
UserAccount	User's identity	Used to identify the user which data can be accessed by this user
	Order History	All history orders of this authenticated user
Ingredients	Ingredient List	Dynamically displaying the status of each ingredient
Manager	Order List	List of orders received from customers
	Order Status	Allows manager to check the status of each order
MealRecommend	History Order	All history orders of this user, used to help customer choose their food
NotifyWaiter	Notify Information	Information about the customer's order status or request
Menu	MenuItems	Menu of dishes currently offered by the restaurant

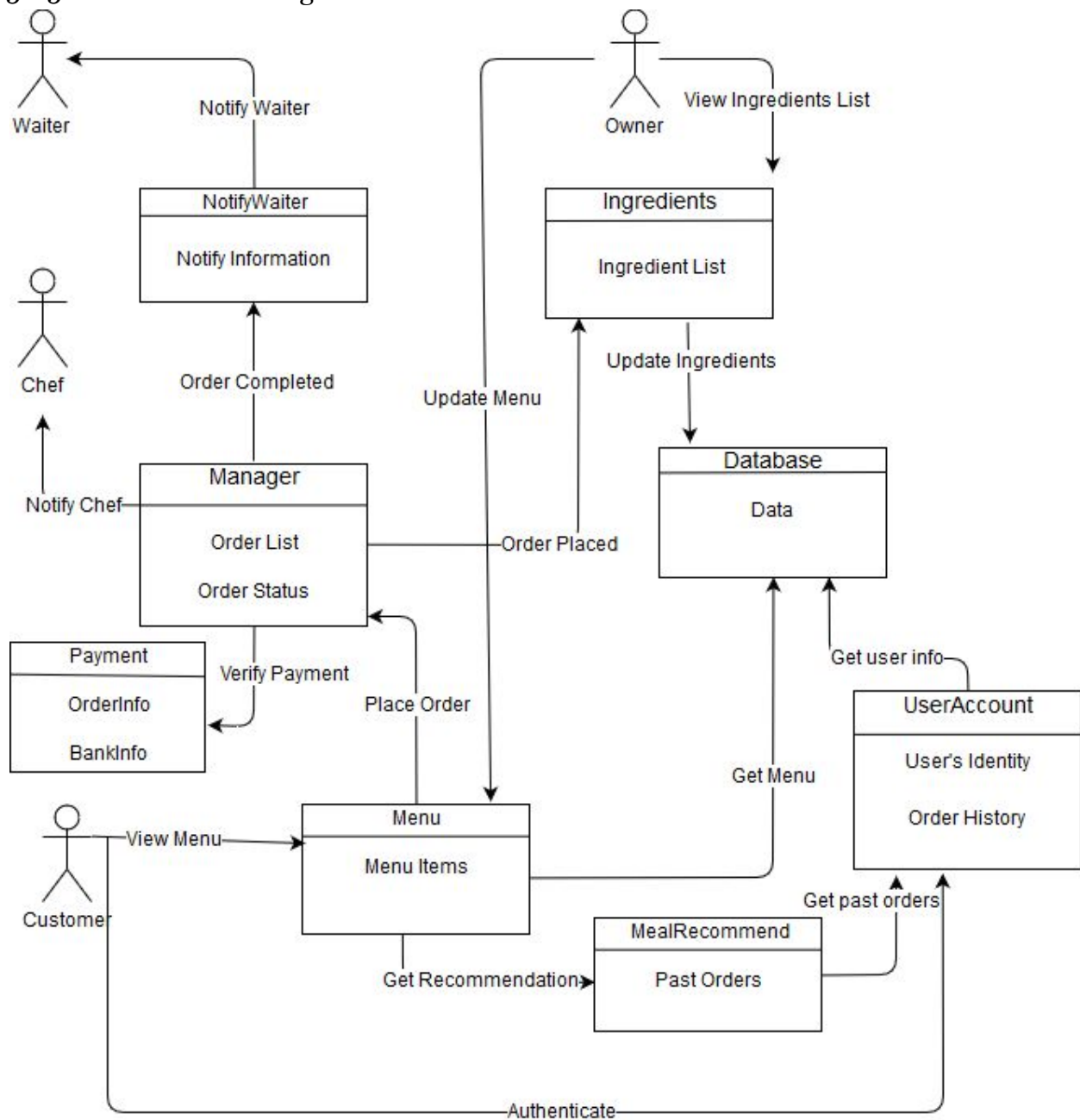
Database	Data	Data stored by the restaurant (menu, user accounts, orders, etc)
Payment	OrderInfo	Information for the order being paid
	BankInfo	Customer's payment information (credit card number, bank routing number, etc)

5.1.4: Traceability Matrix

Domain Concepts	Manager-1			X																					
	UserAccount			X																					
	Menu-1			X	X																				
	MealRecommend-1			X																					
	Database-1			X																					
	Database-2																								
	Ingredients-1								X																
	Ingredients-2																								
	Menu-2																								
	WaiterNeeded								X																
	Manager-2																								
	Payment																								
	MealRecommend-2				X																				

	Use Case	PW																						
	UC1	25	X																					
	UC2	5																						
	UC3	9	X																					
	UC4	15																						
	UC5	5																						
	UC6	8																						
	UC7	4																						
	UC8	4	X																					
	UC9	1																						
	UC10	1	X																					
	UC11	3																						
	UC12	7																						

5.1.5 Domain Model Diagram



5.2: System Operation Contracts

Contract CO1: selectMenu
Operation: selectMenu()
Use Cases: UC-1 (OrderFood)
Preconditions: User must be logged into the app
Postconditions: <ul style="list-style-type: none">• Menu concept instance created• Menu instance connects to database (QueryDB association formed)• Menu displays items queried from the database (DisplayMenu attribute used)

Contract CO2: addFood
Operation: addFood(foodID: integer, quantity: integer)
Use Cases: UC-1 (OrderFood)
Preconditions: User must be on the menu page
Postconditions: <ul style="list-style-type: none">• Manager concept instance created• Manager creates an object in the OrderQueue for this order (AddOrder association formed)• Manager updates order object whenever user updates their order (OrderStatus attribute modified)

Contract CO3: confirmOrder
Operation: confirmOrder(foodItems: array, quantityFoods: array, foodItemCost: float)
Use Cases: UC-1 (OrderFood)
Preconditions: User must have selected at least 1 item to proceed
Postconditions: <ul style="list-style-type: none">• Manager finalizes order object (OrderStatus attribute modified)• After it is finalized, order object remains in OrderQueue• User directed to the payment page

Contract CO4: confirmPayment
Operation: confirmPayment(paymentType: paymentType, paymentInfo: array, subtotal: float, tax: float, gratuity: float, total: float)
Use Cases: UC-1 (OrderFood)
Preconditions: User must have entered in payment information
Postconditions: <ul style="list-style-type: none"> • Payment concept instance created • Payment was associated with Manager (OrderPayment association created) • Once order is placed, status is updated (OrderStatus attribute modified) • Ingredients concept instance created • Ingredients was associated with Manager (UpdateIngredient association created) • User directed to order confirmation page

Contract CO5: completeOrder
Operation: completeOrder(foodItems: array, orderType: string)
Use Cases: UC-3 (OrderComplete), UC-6 (FinishOrder)
Preconditions: Chef must have been finished preparing the food for the order
Postconditions: <ul style="list-style-type: none"> • WaiterNeeded concept instance created • WaiterNeeded was associated with Manager (NotifyWaiter association formed) • Manager finalized order object (OrderStatus attribute modified) • Order object has been removed from Order Queue

Contract CO6: requestAssistance
Operation: requestAssistance(tableID: integer)
Use Cases: UC-4 (AssistanceNeeded)
Preconditions: User must be logged into customer app or using table app
Postconditions: <ul style="list-style-type: none"> • WaiterNeeded concept instance created • WaiterNeeded was associated with Manager (NotifyWaiter association formed)

5.3: Mathematical Model

5.3.1: Ingredient Prediction System

To perform ingredient prediction, a regression analysis algorithm is needed. The first algorithm considered is RANSAC, or Random Sample Consensus, which is an iterative approach to a linear regression model that ignores outliers. The RANSAC algorithm involves repeatedly selecting 2 random points and calculating how many inliers are within a threshold of the line connecting the 2 points. By maximizing the number of inliers, we can obtain a fitted line that can reasonably predict the trend. However, since RANSAC relies on randomness, it is not deterministic and the results will be inconsistent. Also, since this is a linear regression model, the predictions may suffer if there is not a linear relationship in the data.

An alternative to this is to use the Levenberg-Marquardt non-linear least squares algorithm. This algorithm refines the parameters iteratively using the least squares method and the Taylor series expansion. Least squares algorithms are much more susceptible to outliers, but the predictions of the algorithm should be slightly more nuanced since it is looking for a non-linear trend in the data. However, the algorithm is considerably more complex and is not guaranteed to converge. In that case, it may be necessary for us to use a backup algorithm (such as the RANSAC approach) or to simply state that a trend cannot be found.

The Levenberg-Marquardt algorithm uses the iterative approximation:

$$f(x_i, \beta + \delta) \approx f(x_i, \beta) + \mathbf{J}_i \delta,$$

where

$$\mathbf{J}_i = \frac{\partial f(x_i, \beta)}{\partial \beta}$$

is the gradient of f with respect to β . To start, β must be initialized to a guess of the global minimum, standardized at (1, 1). From the above equations, we can arrive at

$$(\mathbf{J}^T \mathbf{J}) \delta = \mathbf{J}^T [\mathbf{y} - \mathbf{f}(\beta)],$$

where \mathbf{J} is the Jacobian matrix, which can be solved for δ . This is repeated until the solution converges.

5.3.2: Recommendation and Review Systems

Demo 1 Goal: Content Based Filtering

When it comes to the organization of the food items within the recommendation and review systems, we currently believe the most ideal way would be to cluster the food items themselves within their respective categories. With these clusters such as “red meat”, “pasta”, “salad”, etc. we can alter the popularity based on the consensus of multiple customers as well as probability of said food item appearing within a customers recommendations. As an example, if a customer were to answer that they prefer pasta food items over all else, the pasta food items will have a higher chance of appearing in their recommendations. Furthermore, at the end of each customer’s meal they will be given the option to review their meal which will further alter the probabilities of their recommendations as well as the popularity of the finished meal. The review system will

be a “5 Star” rating system that will incorporate both the rating itself as well as customer comments in the calculation of the popularity and further recommendation of the food items to customers. This would be implemented in order to increase the accuracy of our system with regards to our specific and generalized customer bases.

user_food_preferences = <P(dairy), P(red meat), P(pasta), ... , P(salad)>

Demo 2 Goal: Collaborative Filtering

After Demo 1, we will be expanding on the content based filtering algorithm by taking in other user’s meal ordering patterns into account when recommending meals for registered users. Since the probabilities of a user liking an item from a particular food group will be stored in a vector, *cosine similarity* will be used to determine what other users have similar meal purchase patterns. Since *cosine similarity* measures the angle between two vectors, it can provide a way to measure how close 2 people’s purchase patterns are. Then we can recommend food items that similar users have purchased to other users.

A = user1_food_preferences = <P₁(dairy), P₁(red meat), P₁(pasta), ... , P₁(salad)>

= <A₁, A₂, A₃, ... , A_i>

B = user2_food_preferences = <P₂(dairy), P₂(red meat), P₂(pasta), ... , P₂(salad)>

= <B₁, B₂, B₃, ... , B_i>

$$\text{similarity} = \cos(\theta) = \frac{\mathbf{A} \cdot \mathbf{B}}{\|\mathbf{A}\| \|\mathbf{B}\|} = \frac{\sum_{i=1}^n A_i B_i}{\sqrt{\sum_{i=1}^n A_i^2} \sqrt{\sum_{i=1}^n B_i^2}}$$

Section 6: Project Size Estimation

UAW Calculation:

Actor name	Description	Complexity	Weight
Customer	Customer is interacting with the system via a graphical user interface.	Complex	3
Waiter/Maitre D	Same as Customer	Complex	3
Owner	Owner is able to create accounts for	Complex	3

	employees through a graphical user interface		
Database	Database is a system interacting through a standard protocol	Average	2
Chef	Chef interacts through a text-based User interface.	Average	2

Unadjusted Actor Weight (UAW) = $2*2 + 3*3 = 13$

Use case classification:

Use Case	Description	Category	Weight
(UC-1) Order food	A complex user interface where customer may select one of many options. 3 Supporting Actors. (Chef, Database, Waiter) 7 steps for a successful scenario.	Complex	15
(UC-2) Suggest	Suggest an order using data from a response from the customer) No user interface. One supporting actor (Customer)	Simple	5
(UC-3) Order Complete	A simple button to end an order. Has 3 steps to a successful scenario. One supporting actor. (Database)	Simple	5

(UC-4) Assistance needed	A simple user interface to call a waiter over when needed. 5 Steps to a successful scenario and 2 supporting actors. (Database and Waiter)	Average	10
(UC-5) GetQueue	A simple user interface button for the chef to see the current orders placed. <3 steps for successful scenario. 1 Supporting actor (Database)	Simple	5
(UC-6) FinishOrder	A user interface button for the chef to end an order. (Similar to UC-3)	Simple	5
(UC-7) ViewStats	A simple user interface to call the database to view the statistics of the restaurant. 1 Supporting Actor (Database)	Simple	5
(UC-8) Predict	A complex interface to predict what each customer would like to order using previous orders and quiz results. >7 steps with 2 supporting actors. (Database, Customer)	Complex	15
(UC-9) EditMenu	A moderate user interface that allows the owner to	Average	10

	modify the existing menu. ~5 Steps with one supporting actor (Database)		
(UC-10) Update Inventory	A simple interface to add amount of ingredients when supply increases. One supporting actor (Database)	Simple	5
(UC-11) Recognize	A moderate UI to take a picture of a customer's face to bring up previous orders. 4 Steps with only one supporting actor. (Database)	Average	10
(UC-12) Register	A Moderate UI which allows customers to register/login to the system. This UI will also be used for employees to login. 4 Steps to Success Scenario. 1 supporting actor (database)	Average	10

$$\text{UUCW} = 6 \times 5 \text{ Simple} + 4 \times 10 \text{ Average} + 2 \times 15 \text{ Complex} = 100$$

Technical Complexity Factor:

Technical factor	Description	Weight	Perceived Complexity	Calculated Weight
T1	Distributed, Web-based system, because of Chef's App, Server's App, Customer's App, and	2	5	$2 \times 5 = 10$

	Waiters App			
T2	Chef will expect the app to respond in a quickly manner. To make the orders in a reasonable time.	1	2	$1 \times 2 = 2$
T3	End-user would expect his/her orders to be place quickly, and for waiter to respond in a timely manner	1	1	$1 \times 1 = 1$
T4	Code to analyze customers previous orders along with previous quiz results will be seemingly complex. How to weight each response and previous ratings will be difficult.	1	4	$1 \times 4 = 4$
T5	Reusable design or code is not a part of our plan	1	0	$1 \times 0 = 0$
T6	Ease of install is not important	0.5	0	$.5 \times 0 = 0$
T7	Ease of use is very important since we want our customers to prefer to uses our system instead of traditional methos.	0.5	5	$5 \times 0.5 = 2.5$
T8	Portability to other platforms is very important to us as our customers will have different types of phones/devices.	2	5	$2 \times 5 = 10$
T9	System Maintenance will be at the Owners discretion. (UC-9/UC-12).	1	2	$1 \times 2 = 2$
T10	Parallel Processing is one of the most important parts of our system as multiple users(customers/waiters)	1	5	$1 \times 5 = 5$

	will be using the app at the same time.			
T11	Sensitive account information (such as passwords) will be stored in an encoded format for security purposes	1	2	1x2=2
T12	Third parties (such as the customer) are very important for our system to function.	1	4	1x4=4
T13	End-User training will only for waiters/chefs. And even this is minimal.	1	1	1x1=1
Total				43.5

$$TCF = 0.6 + 0.01 * 43.5 = 1.035$$

An finally calculating our UCP:

Previous results:

UUCW=100

UAW=13

TCF=1.035

ECF=1 (Given by Professor)

$$UCP = (UUCW + UAW) \times TCF \times ECF$$

$$UCP = (100 + 13) * 1.035 * 1 = 116.955$$

Rounding to...

$$UCP = 117$$

Section 7: Project Management

Weekly Meetings

We plan to meet at least once a week, either in person or online (through Google Hangouts) in order to keep everyone updated with each sub-team's progress.

Methods of Communication

We have a GroupMe and a Slack workspace environment for communicating with each other. The Slack workspace environment has channels for each subteam.

Shared Resources

Our group is using a Google Drive folder for keeping track of report work, since Google Drive facilitates collaboration. GitHub and Git will be used to keep track of progress of our software application.

Disaster Plan

We will enforce internal deadlines for project milestones as listed in the plan of work. If those deadlines are not met, then other group members will have to pitch in to ensure a milestone has been achieved.

Section 8: Plan of Work

Functionality

Our team will be split up into subdivisions of groups of 1, 2, or 3 people. The subdivisions that we believe will require more work will have 3 people, while simpler tasks may have less. Here is the breakdown of the project tasks and who is assigned to each one:

#	Feature Subteams	Names
1	Mobile Applications	<ul style="list-style-type: none">• Taras Tysovskyi• Lieyang Chen• Hongpeng Zhang
2	Restaurant Website	<ul style="list-style-type: none">• Arushi Tandon• Yuwei Jin
3	Database and API Design	<ul style="list-style-type: none">• Yuwei Jin• Chris Lombardi• Taras Tysovskyi
4	Recommendation and Review Systems	<ul style="list-style-type: none">• Chris Gordon• Seerat Aziz
5	Ingredient Prediction and Reservation Systems	<ul style="list-style-type: none">• Alex Gu• Chris Lombardi

**Note that some developers are listed twice, we believe having one “expert” on two groups will help integrate the groups together. For example, Taras will integrate the Mobile app and the Database/Accounts together.

Timeframe

2/25 - 3/3	3/4 - 3/10	3/11 - 3/17	3/18 - 3/24	3/25 - 3/31	4/1 - 4/7	4/8 - 4/14	4/15 - 4/21	4/22 - 4/28	4/29 - 5/5	5/6 - 5/12
Report 2.1	Report 2.2	Final Report 2	Spring Break	First Demo		Report 3.1		Second Demo	Final Report 3 Reflective Essay	E-Archive Due
API Design										
Mobile Application Front End Dev										
Testing Facial Recognition API										
				OpenCV Facial Recognition (Back Up)						
Website Front End Dev										
		Website		Admin Dev						
					Adding features to Website Admin					
Plan Menu										
Plan Rating System										
	Rec/Review Backend Dev									
Define Database Structure										
		Ingredient Pred.		Backend Dev						
		Reservation		System Backend Dev						
								Debugging/Tuning		

API: Many of the other components of this system rely on communicating with the server via API endpoints. Hence it is crucial that we agree on the API endpoints that our server will expose early on in the process. We plan for this to be done in the first 2 weeks. At this point front-end teams can start developing the apps and websites, while the back end team can work on actually writing the code that implements the API.

Mobile Applications: We are hoping to have basic customer, table, chef and serve apps done within the first 5 weeks. Since all the heavy lifting is done by the server, the apps will be just a front end that makes HTTP calls to the server and displays the data it receives from it. Chefs app is the simplest one to make, since it only has one view that displays the current orders. Table and Customer apps share a lot of the same views (menu, order, recommendations) which would allow us to reuse a lot of the same code.

Facial Recognition System: We will use OpenCV to perform face detection. Once a face that takes up a significant portion of the photo is detected (this will help us ensure this is a face of a customer sitting in front of the table, instead of people passing by), we will use a third party facial recognition system to uniquely identify the user. We expect the aforementioned process, as well as integrating it into our apps to take around 2-3 weeks. If the accuracy rate of the third-party software is low or it's difficult to integrate, we will attempt to develop our own model using OpenCV, which should take additional 2-3 weeks.

Recommendation and Review Systems: We first need to define our menu items and identify attributes that can be used in the quiz (1 week). Then we will develop an algorithm that takes the user’s selected meals, “favorited” meals, and meal reviews to generate more accurate suggestions for the future (2-3 weeks). Moreover, we also have to design a review system that would work best for this subproblem (1 week).

Ingredient Prediction System: The bulk of the logic that the ingredient prediction system will use is based off of trends in order history, so it will make heavy use of the central database. As a starting point, the database structure will have to be well defined (~1 week). Beyond that, implementation and refinement of the prediction algorithm will be the next step (2 weeks). Any extensions to this system should be relatively simple,

with only some minor tuning and adjustments needed (1 week).

Customer Reservation Systems: The customer reservation system is relatively simple, only requiring some database entries to be made on the back end. (1 week) The majority of work involving the reservation system lies in interfacing with other aspects of the overall restaurant automation system (~1-2 weeks).

Restaurant website: The overall structure of the restaurant website needs to be established first. The static elements of the restaurant website, such as the menu of the restaurant and the ordering and reservation pages will be completed first (2 weeks). The basic functionalities of the admin console, such as the statistics and ingredient prediction pages will be the next step (2 weeks). Since the website will provide the front-end UI for many of the component systems, interfacing with the various systems of the Restaurant Automation system will be completed throughout the semester as they achieve various degrees of completion. Additional features on the admin console, such as editing the menu will be stretch goals (2+ weeks).

Section 9: References

1. Why W8 - Fall 2018 Restaurant Automation Project
2. FoodEZ - Spring 2015 Restaurant Automation Project
3. Professor Marsic's Restaurant Automation Project Description
(<https://www.ece.rutgers.edu/~marsic/books/SE/projects/Restaurant/>)
4. Spyce (Boston restaurant with a robotic chef) -
<https://www.greenbiz.com/article/full-service-automation-restaurants-changing-food-industry>