User Requirements

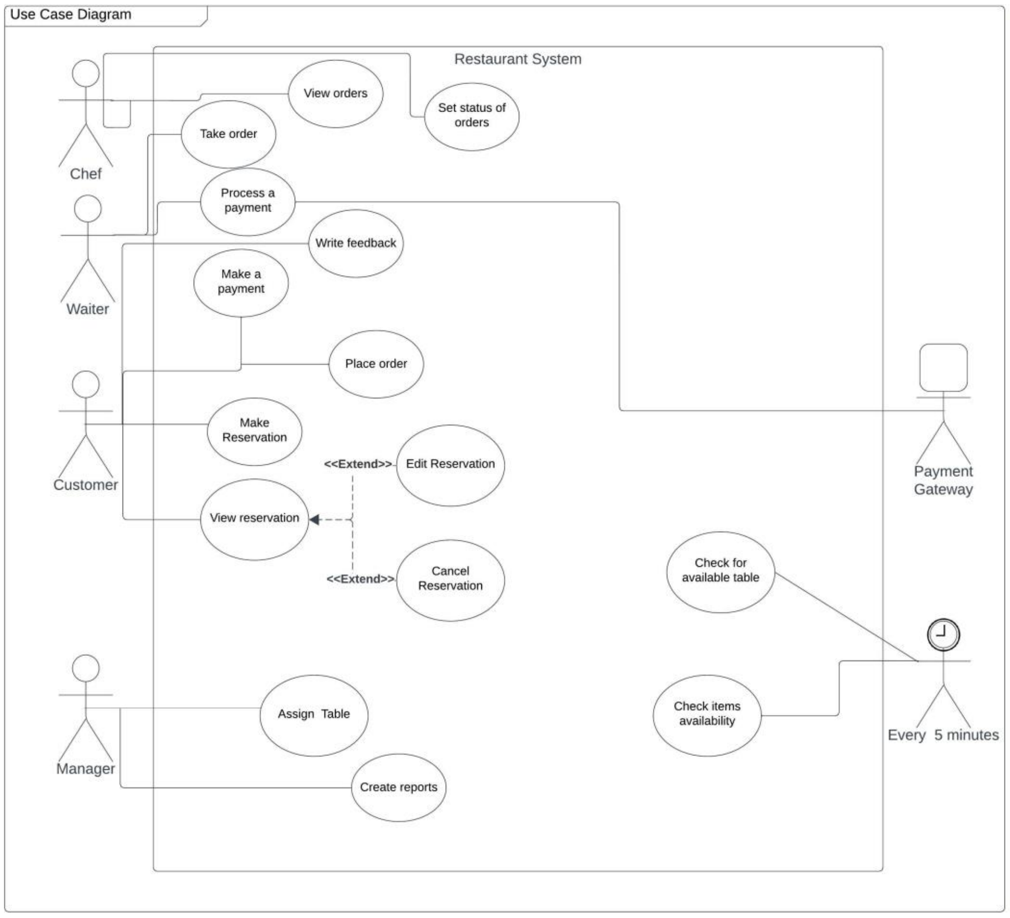
The Restaurant Management System(RMS) is designed to perform the operations of a restaurant efficiently. This system will be used by customers to make reservations, place orders, and provide feedback. Additionally, the system will be utilized by employees of the restaurant to assist customers, prepare orders, and manage the menu, inventory, and payments.

Customers are able to make reservations through the app by selecting a date, time, and number of guests. The system then checks for available tables and confirms the reservation, providing the customer with a reservation number. Customers can also edit or cancel their reservations if needed. For providing feedback, customers can rate their experience, leave comments on specific dishes, or describe their overall experience in the restaurant. This feedback is valuable for maintaining the quality of service. Customers can also place orders directly through the app, either while dining in or before arriving. They can browse the menu, select items, customize dishes, and add them to their order. Once finalized, the order is sent directly to the kitchen for preparation.

Employees, such as Managers, can assign tables if a customer walks into the restaurant without a prior reservation. The manager uses the system to see available tables in real-time and assigns them accordingly, ensuring that all reservations are accounted for and walk-ins are accommodated when possible. Waiters can take orders from customers dining in, using tablets or handheld devices to enter orders directly into the system, which automatically sends them to the kitchen for preparation. The waiters are also responsible for serving the food to customers once it’s ready and ensuring all special requests are handled properly. Chefs can view the list of incoming orders in real-time through the system. The system organizes orders based on the time they were placed and the complexity of each dish, allowing chefs to prepare meals efficiently. The chefs can also mark orders as "in preparation," "ready to serve," or "completed," which updates the system and notifies the waiters.

Overall, the Restaurant Management System aims to streamline all operations, enhancing the customer experience and ensuring that the restaurant staff can manage their responsibilities effectively.

Use case diagram



Use case Scenario: Make Reservation

Use Case Scenario: Make Reservation

Actor: Customer

Purpose and Context: A customer wants to reserve a table for a specific date and time.

Assumptions:
1. The customer has already decided on the date and time for the reservation.

Preconditions:
1. The system is operational and table availability is up-to-date.

Basic Flow of Events:

1.The customer accesses the "Make Reservation" option on the system.
2.The system prompts the customer to input the reservation date, time, and number of guests.
3. Customer inputs info.
4.The system checks table availability based on the provided details.
5.The system displays available tables.
6.The customer selects a table from the list of available options.
7.The customer confirms the reservation.
8.The system saves the reservation and provides a confirmation message, including reservation details.

Allternative Flow:

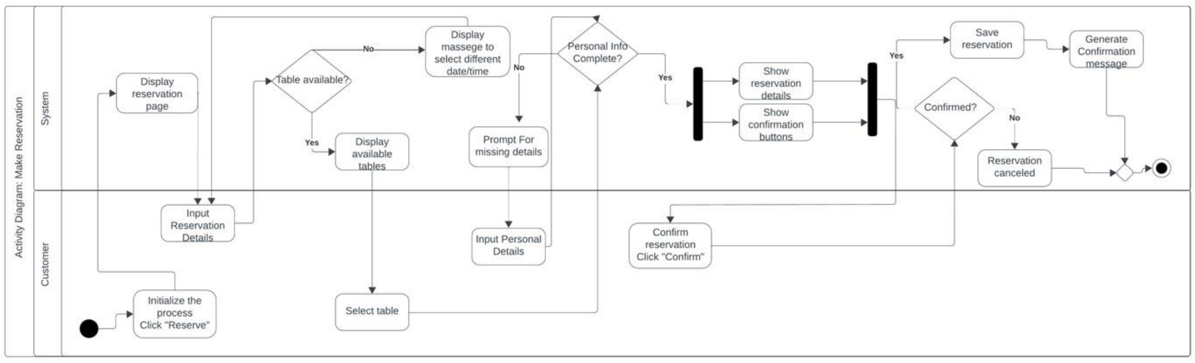
1. No Tables Available:
1.1 The system informs the customer that no tables are available for the selected time and date.
1.2 The system suggests alternative time/date for the reservation.
1.3 The customer choose suggested time/date and continue from point 5 of basic flow.

2. Incomplete Personal Details:
2.1 The system prompts the customer to fill in missing mandatory information.
2.2 The customer provides the missing details and continue.

3. Customer doesn't confirm the reservation:
3.1 The reservation is not made.

Postconditions:
Basic:
The reservation is made and saved in the system.
The customer recieves a confirmation
Alternative:
Reservation is not made.

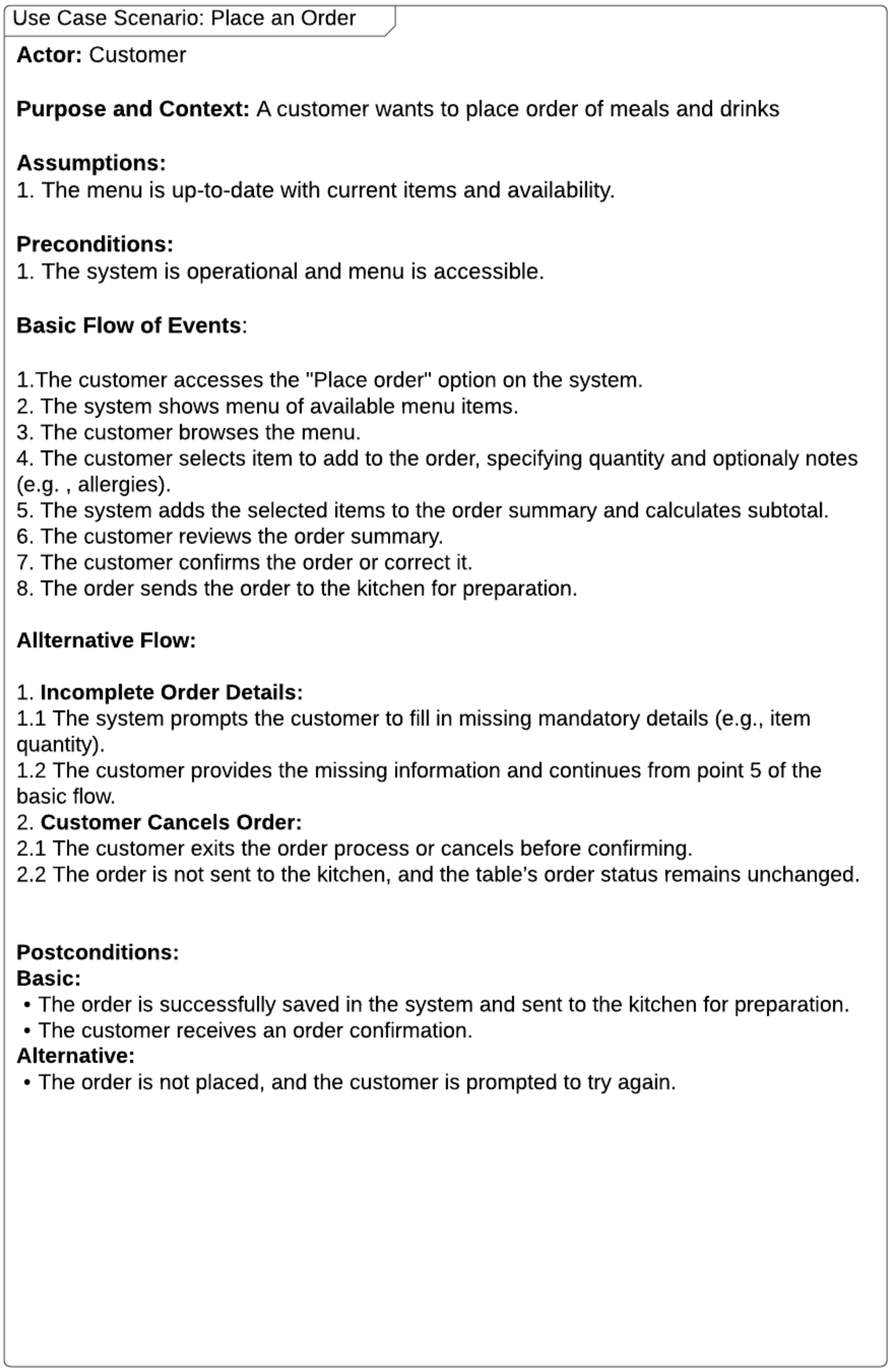
Activity diagram: Make Reservation


Activity Diagram: Make Reservation
System
Customer
Initialize the process Click "Reserve"
Display reservation page
Input Reservation Details
Table available?
No
Yes
Display massege to select different date/time
Display available tables
Select table
Personal Info Complete?
No
Prompt For missing details
Input Personal Details
Yes
Show reservation details
Show confirmation buttons
Confirm reservation Click "Confirm"
Confirmed?
Yes
No
Save reservation
Generate Confirmation message
Reservation canceled

The process of making a reservation in the restaurant system is simple and intuitive for the customer. When a customer decides they want to reserve a table, they open the restaurant app and click on the "Reserve" button. They are asked to provide details like the date and time they want to visit and the number of people coming. After inputting these details, the system automatically checks if there are available tables for the requested date and time.

If a table is available, it shows the customer a list of available options, and they can choose their preferred one. Sometimes, if a table isn't available at the selected time, the system suggests other possible times or dates that could work. Once the customer selects a table and fills out any necessary information (like personal details for identification), they proceed to confirm the reservation. After confirmation, the system generates a summary of the reservation, and the customer receives a confirmation message, either on their app or by email. If the customer decides not to confirm, the reservation is simply not made, and they can try again later.

Use case scenario: Place an order



Use Case Scenario: Place an Order

Actor: Customer

Purpose and Context: A customer wants to place order of meals and drinks

Assumptions:
1. The menu is up-to-date with current items and availability.

Preconditions:
1. The system is operational and menu is accessible.

Basic Flow of Events:

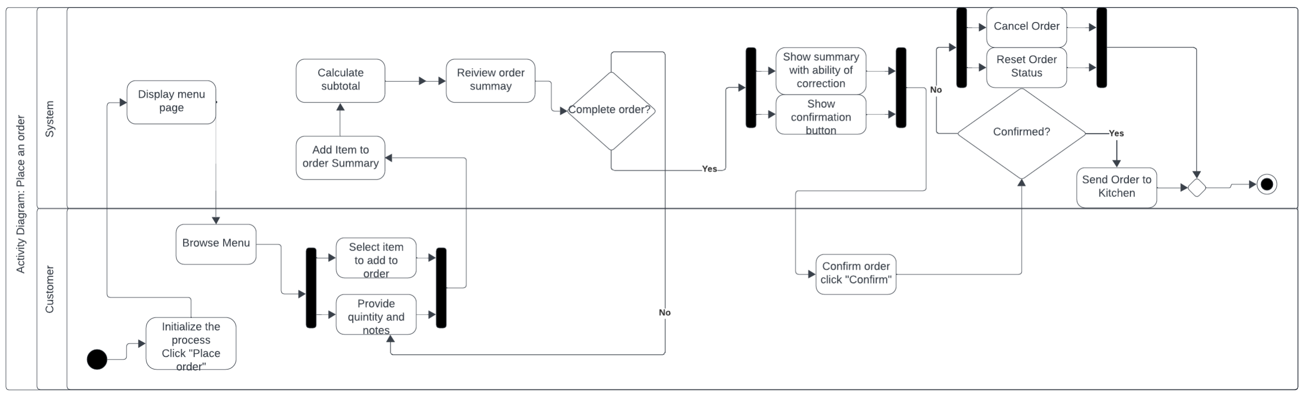
1.The customer accesses the "Place order" option on the system.
2. The system shows menu of available menu items.
3. The customer browses the menu.
4. The customer selects item to add to the order, specifying quantity and optionaly notes (e.g. , allergies).
5. The system adds the selected items to the order summary and calculates subtotal.
6. The customer reviews the order summary.
7. The customer confirms the order or correct it.
8. The order sends the order to the kitchen for preparation.

Allternative Flow:

1. **Incomplete Order Details:**
1.1 The system prompts the customer to fill in missing mandatory details (e.g., item quantity).
1.2 The customer provides the missing information and continues from point 5 of the basic flow.
2. **Customer Cancels Order:**
2.1 The customer exits the order process or cancels before confirming.
2.2 The order is not sent to the kitchen, and the table's order status remains unchanged.

Postconditions:
Basic:
• The order is successfully saved in the system and sent to the kitchen for preparation.
• The customer receives an order confirmation.
Alternative:
• The order is not placed, and the customer is prompted to try again.

Activity diagram: Place an Order


Activity Diagram: Place an order
System
Customer
Initialize the process Click "Place order"
Display menu page
Browse Menu
Select item to add to order
Provide quintity and notes
Add Item to order Summary
Calculate subtotal
Reiview order summay
Complete order?
Yes
No
Show summary with ability of correction
Show confirmation button
No
Cancel Order
Reset Order Status
Confirmed?
Yes
Confirm order click "Confirm"
Send Order to Kitchen

Placing an order at the restaurant using the system is designed to be just as seamless. When customers are ready to order, whether they are dining in or ordering ahead, they go to the "Place Order" section. The system presents them with the current menu, allowing them to browse through the available dishes.

The customer can click on any item they want to order. If they have specific preferences—like wanting a dish with less spice or avoiding certain ingredients—they can add notes before finalizing the item. Once they've selected an item, they provide the quantity they'd like and add it to the order summary. The system then calculates the subtotal if all the necessary iformation is provided the system continues to the next step. If not all the information was provided the system asks customer to correct the order.

After all items are chosen, the customer is shown an order summary. Here, they can check everything they've added, make corrections, or remove items. If everything looks good, they click "Confirm" to finalize the order, and the system sends the order to the kitchen for preparation. If at any point the customer changes their mind, they can choose to cancel the order, and it will simply not be processed. This process gives customers full control of their meal selection, ensuring they can tailor the experience to their taste and preferences, while also making it easy for the kitchen to receive clear instructions.

Use case scenario: Process Payment

Use Case Scenario: Process Payment

Actor: Waiter
Purpose and Context: A waiter needs to process the payment for a customer's order after they have finished dining.
Assumptions:
1. The customer has finished their meal and requested the bill.
2. The order has been fully prepared, served, and is recorded in the system.

Preconditions:
1. The system is operational and connected to the payment processing service.
2. The customer's order exists in the system and is marked as ready for payment.

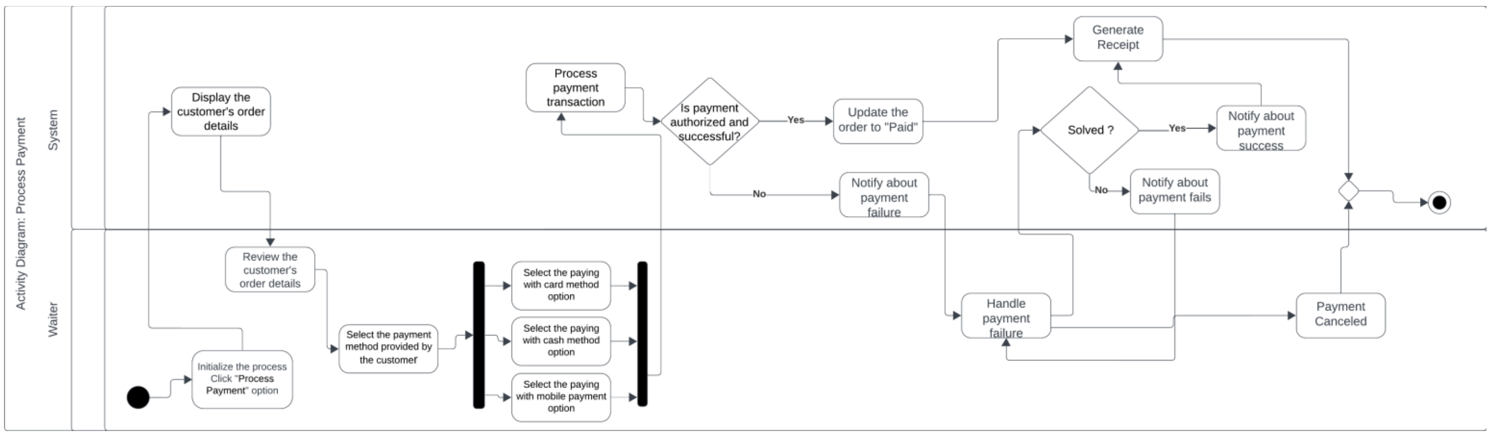
Basic Flow of Events:
1. The waiter accesses the "Process Payment" option on the system.
2. The system displays the customer's order summary, including all items and the total amount due.
3. The waiter presents the bill to the customer.
4. The customer reviews the bill and provides a payment method (e.g., cash, credit card, mobile payment).
5. The waiter selects the payment method in the system.
6. The waiter inputs any necessary payment details (e.g., entering cash amount received or initiating card payment).
7. The system processes the payment transaction.
8. The system confirms that the payment was successful.
9. The system updates the order status to "Paid."
10. The system generates a receipt.
11. The waiter provides the receipt to the customer and thanks them.

Alternative Flow:
1. **Payment Declined**:
   - **1.1** The system indicates that the payment was declined or failed.
   - **1.2** The waiter informs the customer of the declined payment.
   - **1.3** The customer provides an alternative payment method.
   - **1.4** The waiter processes the new payment method, returning to step 5 of the basic flow.
2. **Partial Payment / Split Bill**:
   - **2.1** The customer requests to split the bill among multiple payment methods or guests.
   - **2.2** The waiter selects the "Split Payment" option in the system.
   - **2.3** The waiter enters the amount or items each person will pay for.
   - **2.4** The waiter processes each payment separately, repeating steps 5 to 8 for each.
   - **2.5** The system confirms that the total amount has been fully paid.
   - **2.6** The system generates individual receipts for each payment.
   - **2.7** The waiter hands out the receipts to the respective customers.
3. **Payment System Error**:
   - **3.1** The system encounters an error during payment processing (e.g., network failure).
   - **3.2** The system displays an error message to the waiter.
   - **3.3** The waiter informs the customer of the issue and apologizes.
   - **3.4** The waiter retries the transaction or, if unsuccessful, contacts a manager.
   - **3.5** The manager may choose to process the payment using an alternative method (e.g., manual imprint).
4. **Customer Disputes Bill**:
   - **4.1** The customer notices an error on the bill (e.g., incorrect item or amount).
   - **4.2** The customer informs the waiter about the discrepancy.
   - **4.3** The waiter reviews the order details and verifies the issue.
   - **4.4** The waiter corrects the order in the system or contacts a manager if necessary.
   - **4.5** The system updates the order summary and recalculates the total.
   - **4.6** The waiter presents the corrected bill to the customer.
   - **4.7** The customer proceeds with the payment, returning to step 4 of the basic flow.

Postconditions:
- **Basic**:
  - The payment is successfully recorded in the system.
  - The order status is updated to "Paid."
  - The customer's bill is settled, and they receive a receipt.
  - The system reflects accurate sales and inventory data.
- **Alternative**:
  - If payment is unsuccessful, the order remains marked as "Unpaid."
  - The system logs the failed payment attempt.
  - The waiter or manager takes appropriate actions to resolve the issue (e.g., offering alternative payment methods, correcting billing errors).
  - Any adjustments to the order are saved in the system for accurate record-keeping.

Exceptions:
- **System Crash During Transaction**:
  - The system crashes or freezes during the payment process.
  - The waiter restarts the system and verifies whether the payment was processed.
  - If uncertain, the waiter may contact the payment processor or manager before retrying to prevent double charging.
- **Insufficient Funds (Cash Payment)**:
  - The customer does not have enough cash to cover the bill.
  - The waiter politely informs the customer of the shortage.
  - The customer provides an alternative payment method or removes items if possible, subject to restaurant policy.

Activity diagram: Process Payment


Activity Diagram: Process Payment
System
Waiter
Initialize the process Click "Process Payment" option
Display the customer's order details
Review the customer's order details
Select the payment method provided by the customer
Select the paying with card method option
Select the paying with cash method option
Select the paying with mobile payment option
Process payment transaction
Is payment authorized and successful?
Yes
No
Update the order to "Paid"
Notify about payment failure
Generate Receipt
Handle payment failure
Solved ?
Yes
No
Notify about payment success
Notify about payment fails
Payment Canceled

The **Process Payment** activity is designed to ensure a seamless and flexible payment experience for the customer. Once the waiter selects the "Process Payment" option, the system displays the customer's order details, allowing the waiter to confirm the order's accuracy before proceeding.

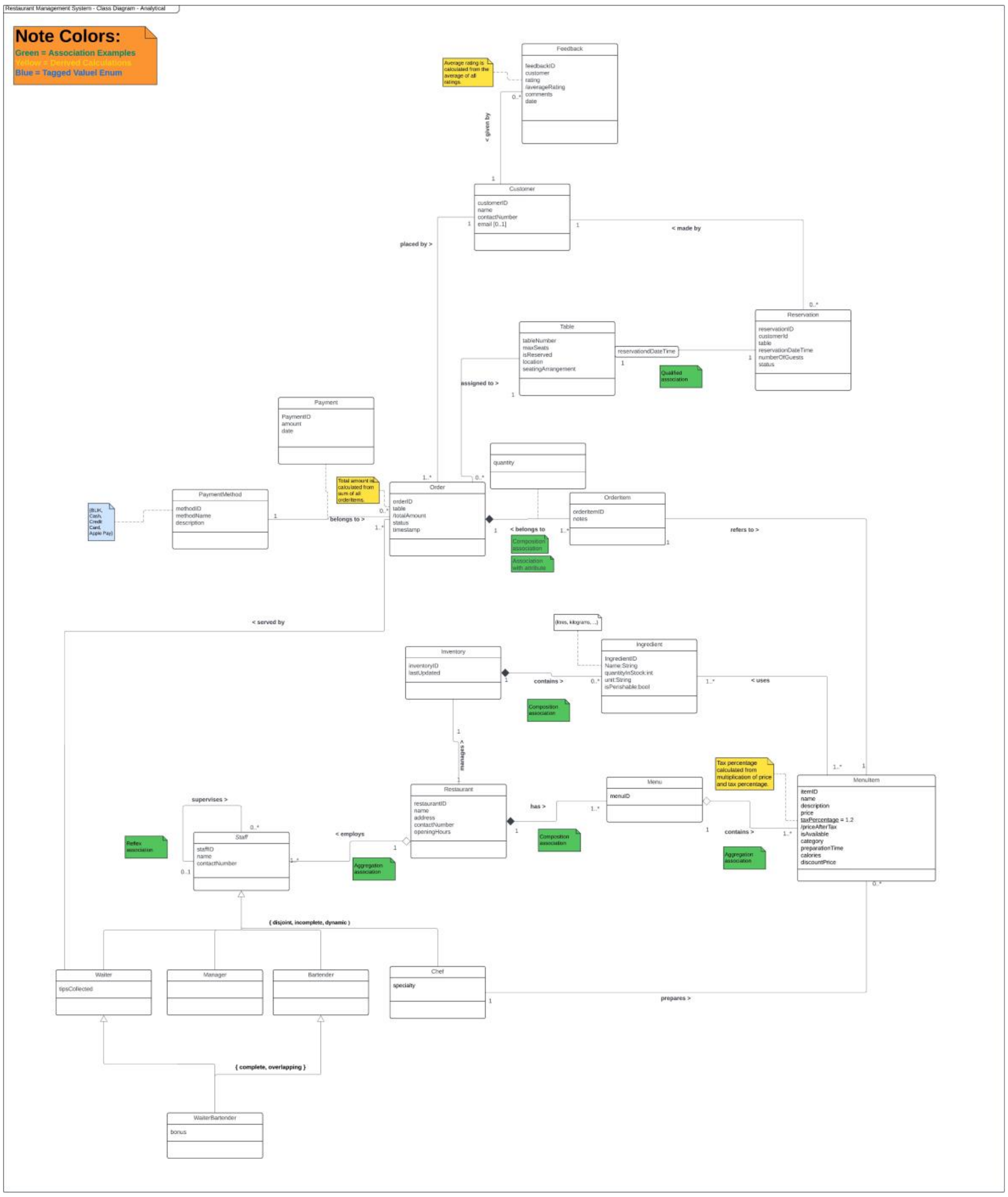
The waiter then chooses the payment method based on the customer's preference. Options include payment by card, cash, or mobile payment methods. The system processes the transaction using the chosen method, ensuring secure and efficient handling of the payment.

If the payment is authorized and successful, the system updates the order status to "Paid" and notifies the waiter about the successful payment. A receipt is generated for the customer as a record of the transaction.

In cases where the payment fails, the system immediately notifies the waiter of the issue. The waiter can attempt to resolve the problem, such as retrying the transaction or choosing an alternative payment method. If the issue cannot be resolved, the payment is canceled, and the waiter informs the customer accordingly.

This structured process ensures that the payment workflow is transparent, secure, and adaptable to various scenarios, minimizing errors and enhancing customer satisfaction.

Class Diagram - Analytical


Restaurant Management System - Class Diagram - Analytical
Note Colors:
Green = Association Examples
Yellow = Derived Calculations
Blue = Tagged Valuel Enum
Feedback
feedbackID
customer
rating
/averageRating
comments
date
Average rating is calculated from the average of all ratings.
< given by
0..*
1
Customer
customerID
name
contactNumber
email [0..1]
placed by >
< made by
1
1
0..*
Reservation
reservationID
customerId
table
reservationDateTime
numberOfGuests
status
Table
tableNumber
maxSeats
isReserved
location
seatingArrangement
reservationdDateTime
Qualified association
assigned to >
Payment
PaymentID
amount
date
quantity
Total amount is calculated from sum of all orderItems.
Order
orderID
table
/totalAmount
status
timestamp
1..*
0..*
OrderItem
orderItemID
notes
< belongs to
Composition association
Association with attribute
refers to >
PaymentMethod
methodID
methodName
description
{BLIK, Cash, Credit Card, Apple Pay}
belongs to >
< served by
{litres, kilograms, ...}
Inventory
inventoryID
lastUpdated
contains >
Ingredient
IngredientID
Name:String
quantityInStock:int
unit:String
isPerishable:bool
< uses
Composition association
manages >
Restaurant
restaurantID
name
address
contactNumber
openingHours
has >
Composition association
Menu
menuID
contains >
Aggregation association
Tax percentage calculated from multiplication of price and tax percentage.
MenuItem
itemID
name
description
price
taxPercentage = 1.2
/priceAfterTax
isAvailable
category
preparationTime
calories
discountPrice
supervises >
Reflex association
Staff
staffID
name
contactNumber
< employs
Aggregation association
0..1
{ disjoint, incomplete, dynamic }
Waiter
tipsCollected
Manager
Bartender
Chef
specialty
prepares >
{ complete, overlapping }
WaiterBartender
bonus

Analytical Class Diagram – Design Description

The analytical class diagram presented above visualizes the comprehensive structure of the restaurant management system. This system models the intricate operations of a restaurant, enabling smooth coordination between customers, staff, inventory, and services. The primary goal is to enhance operational efficiency, ensure customer satisfaction, and optimize resource management within the restaurant.

System Overview

- **Customers**: Customers interact with the system by making reservations, placing orders, making payments, and providing feedback. This interaction is pivotal in creating a personalized dining experience and allows the restaurant to tailor its services to meet customer preferences and expectations.

- **Staff Roles**: Staff members are hierarchically structured with specializations for positions like Chef, Bartender, Waiter, Manager, and WaiterBartender. Each role has specific responsibilities that contribute to the overall operations of the restaurant. This hierarchical structuring ensures clarity in duties and efficient workflow management.

- **Inventory and Ingredients**: The system tracks inventory levels and manages ingredients required for menu items. By connecting inventory and ingredients to menu items, the system ensures proper stock management, minimizes wastage, and supports kitchen operations. This linkage is crucial for maintaining the freshness of ingredients and ensuring that menu items are always available.

- **Tables and Seating Management**: Tables are assigned to orders and reservations to manage customer seating effectively. The system optimizes table allocation based on reservation schedules and walk-in customers, enhancing the dining experience by reducing wait times and maximizing occupancy.

Key Relationships and Interactions

- **Customers Linked to Orders and Feedback**: Customers are directly associated with their orders and feedback. This linkage creates a comprehensive customer interaction flow, allowing the restaurant to track customer preferences, order history, and satisfaction levels. It enables personalized service and targeted marketing efforts.

- **Orders Associated with Menu Items, Tables, and Payments**: Orders are central to the dining experience and are connected to several key components:

    - **Menu Items**: Each order contains one or more menu items selected by the customer. This association ensures accurate preparation and billing.
    - **Tables**: Orders are linked to specific tables, facilitating efficient service delivery by the wait staff.
    - **Payments**: Orders are associated with payments, ensuring that all transactions are accurately recorded and processed.

- **Inventory and Ingredients Connected to Menu Items**: Menu items are composed of various ingredients managed within the inventory system. This connection ensures that the availability of menu items is automatically updated based on inventory levels, preventing situations where customers order items that are out of stock.

Staff Hierarchical Structure and Contributions

- **Generalization of Staff Roles**: The staff hierarchy is represented using generalization in the UML diagram. The base class Staff is specialized into specific roles:

    - **Chef**: Responsible for preparing dishes, managing kitchen operations, and maintaining food quality standards.
    - **Bartender**: Specializes in preparing and serving beverages, managing the bar inventory, and creating

drink menus.
  - **Waiter**: Handles customer orders, serves food and drinks, provides customer service, and manages table assignments.
  - **Manager**: Oversees restaurant operations, manages staff schedules, handles administrative tasks, and ensures overall customer satisfaction.
  - **WaiterBartender**: A versatile role that combines the responsibilities of a waiter and a bartender, offering flexibility in staffing.

- **Supervision Relationships**: The diagram accounts for the supervision relationships between staff roles. For example, managers supervise chefs, bartenders, and waiters, coordinating their efforts to ensure seamless operations. Chefs may oversee kitchen assistants, while head waiters might coordinate the activities of junior waiters.

- **Specific Contributions**:

  - **Chefs** contribute by crafting dishes, innovating menu items, and maintaining high culinary standards.
  - **Bartenders** enhance the dining experience by providing a variety of beverages and engaging with customers at the bar.
  - **Waiters** are the primary point of contact with customers, influencing their overall satisfaction through service quality.
  - **Managers** ensure that all aspects of the restaurant function cohesively, from front-of-house service to back-of-house operations.

UML Constructs and Design Decisions

- **Generalization (Inheritance)**: The use of generalization groups staff members into specialized roles. This allows shared attributes and methods (like StaffID, Name, and ContactNumber) to be defined once in the base Staff class, promoting code reuse and consistency. Specialized classes inherit these attributes and can introduce role-specific properties and behaviors.

- **Aggregation and Composition**:

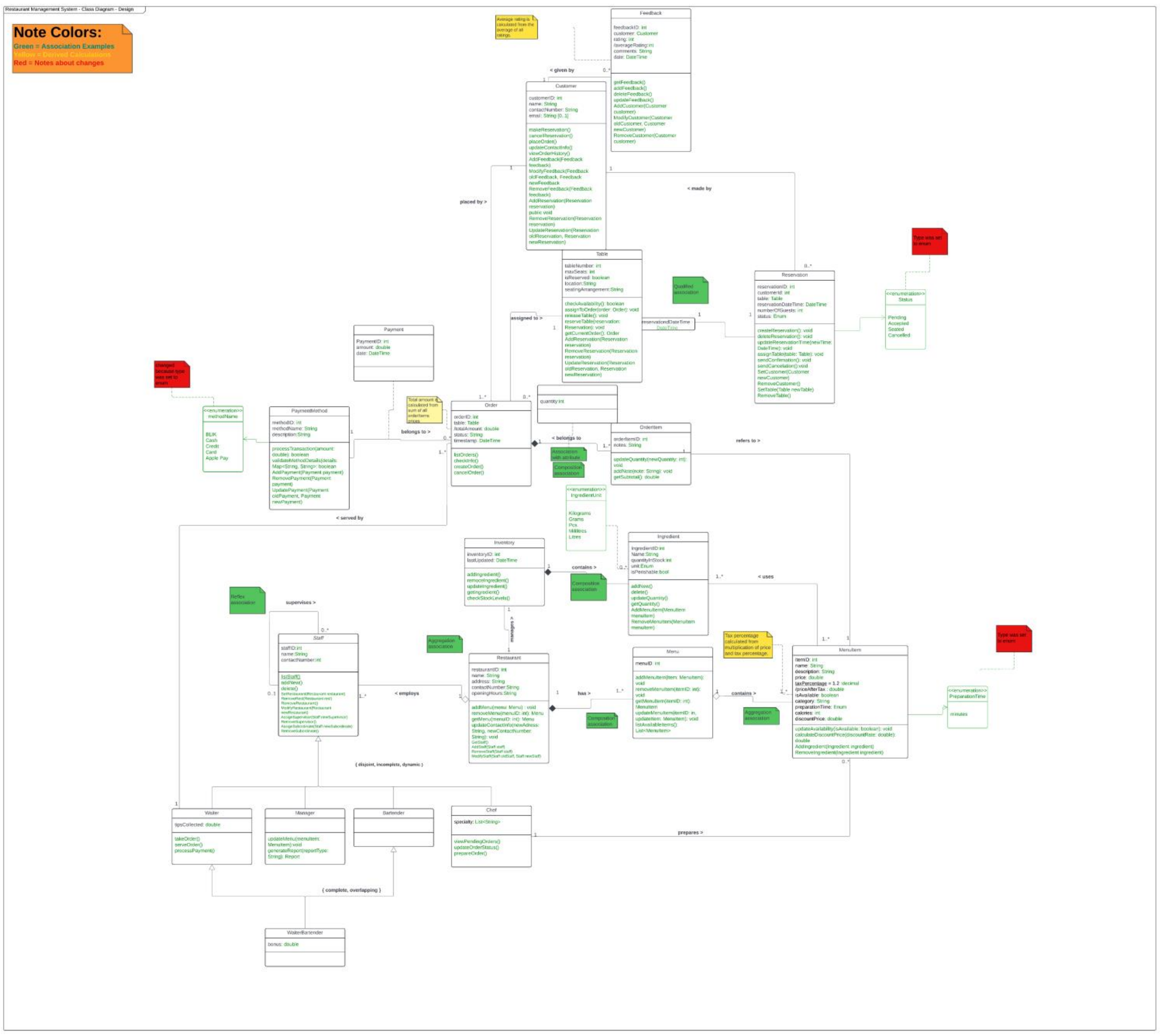
  - **Aggregation**: Represents a whole-part relationship where the part can exist independently of the whole. For instance, a Menu aggregates multiple MenuItem objects. Menu items can exist independently and may be part of multiple menus (e.g., seasonal menus).
  - **Composition**: A stronger form of aggregation indicating ownership and a lifecycle dependency between the whole and its parts. For example, an Order is composed of OrderItem objects. If the order is deleted, its order items cease to exist, reflecting a tight coupling.

- **Associations**:

  - **Multiplicity**: Defines how many instances of a class can be associated with instances of another class. For example, a Customer can have multiple Reservations (one-to-many), but a Reservation is linked to a single Customer (many-to-one).
  - **Bidirectional Associations**: Some associations are navigable in both directions. For instance, Orders and Tables are linked such that the system can identify which table an order is associated with and vice versa.

- **Notes and Explanations**: The diagram includes notes to clarify constructs and design decisions that are not immediately apparent. For example, the decision to model WaiterBartender as a subclass of Staff rather than combining Waiter and Bartender roles through multiple inheritance (which is not supported in some programming languages) is explained.

Design Diagram - Initial Version



Restaurant Management System - Class Diagram - Design
Note Colors:
Green = Association Examples
Yellow = Derived Calculations
Red = Notes about changes
Average rating is calculated from the average of all ratings.
Feedback
feedbackID: int
customer: Customer
rating: int
/averageRating:int
comments: String
date: DateTime
getFeedback()
addFeedback()
deleteFeedback()
updateFeedback()
AddCustomer(Customer customer)
ModifyCustomer(Customer oldCustomer, Customer newCustomer)
RemoveCustomer(Customer customer)
< given by
Customer
customerID: int
name: String
contactNumber: String
email: String [0..1]
makeReservation()
cancelReservation()
placeOrder()
updateContactInfo()
viewOrderHistory()
AddFeedback(Feedback feedback)
ModifyFeedback(Feedback oldFeedback, Feedback newFeedback
RemoveFeedback(Feedback feedback)
AddReservation(Reservation reservation)
public void
RemoveReservation(Reservation reservation)
UpdateReservation(Reservation oldReservation, Reservation newReservation)
placed by >
< made by
Type was set to enum
Table
tableNumber: int
maxSeats: int
isReserved: boolean
location:String
seatingArrangement:String
checkAvailability(): boolean
assignToOrder(order: Order): void
releaseTable(): void
reserveTable(reservation: Reservation): void
getCurrentOrder(): Order
AddReservation(Reservation reservation)
RemoveReservation(Reservation reservation)
UpdateReservation(Reservation oldReservation, Reservation newReservation)
Qualified association
reservationdDateTime
DateTime
Reservation
reservationID: int
customerId: int
table: Table
reservationDateTime: DateTime
numberOfGuests: int
status: Enum
createReservation(): void
deleteReservation(): void
updateReservationTime(newTime: DateTime): void
assignTable(table: Table): void
sendConfirmation(): void
sendCancelation():void
SetCustomer(Customer newCustomer)
RemoveCustomer()
SetTable(Table newTable)
RemoveTable()
<<enumeration>>
Status
Pending
Accepted
Seated
Cancelled
assigned to >
Payment
PaymentID: int
amount: double
date: DateTime
changed because type was set to enum
<<enumeration>>
methodName
BLIK
Cash
Credit
Card
Apple Pay
PaymentMethod
methodID: int
methodName: String
description:String
processTransaction(amount: double): boolean
validateMethodDetails(details: Map<String, String>: boolean
AddPayment(Payment payment)
RemovePayment(Payment payment)
UpdatePayment(Payment oldPayment, Payment newPayment)
Total amount is calculated from sum of all orderItems prices
belongs to >
Order
orderID: int
table: Table
/totalAmount: double
status: String
timestamp: DateTime
listOrders()
checkInfo()
createOrder()
cancelOrder()
quantity:int
< belongs to
Association with attribute
Composition association
OrderItem
orderItemID: int
notes: String
updateQuantity(newQuantity: int): void
addNote(note: String): void
getSubtotal(): double
refers to >
< served by
<<enumeration>>
IngredientUnit
Kilograms
Grams
Pcs
Millilitres
Litres
Inventory
inventoryID: int
lastUpdated: DateTime
addIngredient()
removeIngredient()
updateIngredient()
getIngredient()
checkStockLevels()
contains >
Composition association
Ingredient
IngredientID:int
Name:String
quantityInStock:int
unit:Enum
isPerishable:bool
addNew()
delete()
updateQuantity()
getQuantity()
AddMenuItem(MenuItem menuItem)
RemoveMenuItem(MenuItem menuItem)
< uses
Reflex association
supervises >
Staff
staffID:int
name:String
contactNumber:int
listStaff()
addNew()
delete()
SetRestaurant(Restaurant restaurant)
RemoveRest(Restaurant rest)
RemoveRestaurant()
ModifyRestaurant(Restaurant newRestaurant)
AssignSupervisor(Staff newSupervisor)
RemoveSupervisor()
AssignSubordinate(Staff newSubordinate)
RemoveSubordinate()
Aggregation association
manages >
< employs
Restaurant
restaurantID: int
name: String
address: String
contactNumber:String
openingHours:String
addMenu(menu: Menu) : void
removeMenu(menuID: int): Menu
getMenu(menuID: int): Menu
updateContactInfo(newAdress: String, newContactNumber: String): void
GetStaff()
AddStaff(Staff staff)
RemoveStaff(Staff staff)
ModifyStaff(Staff oldStaff, Staff newStaff)
has >
Composition association
Menu
menuID: int
addMenuItem(item: MenuItem): void
removeMenuItem(itemID: int): void
getMenuItem(itemID: int): MenuItem
updateMenuItem(itemID: in, updateItem: MenuItem): void
listAvailableItems(): List<MenuItem>
Tax percentage calculated from multiplication of price and tax percentage.
contains >
Aggregation association
MenuItem
itemID: int
name: String
description: String
price: double
taxPercentage = 1.2 :decimal
/priceAfterTax : double
isAvailable: boolean
category: String
preparationTime: Enum
calories: int
discountPrice: double
updateAvailability(isAvailable: boolean): void
calculateDiscountPrice(discountRate: double): double
AddIngredient(Ingredient ingredient)
RemoveIngredient(Ingredient ingredient)
Type was set to enum
<<enumeration>>
PreparationTime
minutes
{ disjoint, incomplete, dynamic }
Waiter
tipsCollected: double
takeOrder()
serveOrder()
processPayment()
Manager
updateMenu(menuItem: MenuItem):void
generateReport(reportType: String): Report
Bartender
Chef
specialty: List<String>
viewPendingOrders()
updateOrderStatus()
prepareOrder()
prepares >
{ complete, overlapping }
WaiterBartender
bonus: double

Design Decisions

The design class diagram illustrates the changes necessary to model UML constructs that do not exist in the C# language. The changes introduced are highlighted in green with some additional markups in yellow and red. Information in regards to qualified associations, composition associations, associations with attributes,overlapping, dynamic, disjoint, and abstract attributes, an so on will be described in the future.

Optional Attributes

Optional attributes are attributes that may contain no value. Optional attributes are simply C# properties that are marked as being nullable - e.g “?”, which is to say they may contain null as a value. In the diagram they are marked as [0..1]

Multi-value attributes

Multi-value attributes are implemented as lists. Chefs specialty in the diagram is a multi-value attribute marked as a list of strings, to allow a chef workingin the restaurant to be responsible for more than one thing.

Derived attributes

Derived attributes utilize that get feature when declaring attributes in c#. In most instances showcased, the derived attributes would have the logics directly created on the getter and would return the final total. Ensuring an automatic creation of the derived attributes based on the other values that create the base of a derived attribute.
For example the totalAmount attribute in Order would be created as:

```
TotalAmount => orderItems.Sum(item => item.TotalPrice);
```

where orderItems is a list of all positions ordered.

Tagged value

Tagged values are implemented using the enumeration class method. Using enum types, each attribute will have their own separate class where the specific values are stored. Furthermore, due to the usage of enumerations the design class diagram includes the notations of those classes. (e.g Method Name) which transform the previously used note notation for tagged values to an actual class related to the given attribute.

Associations

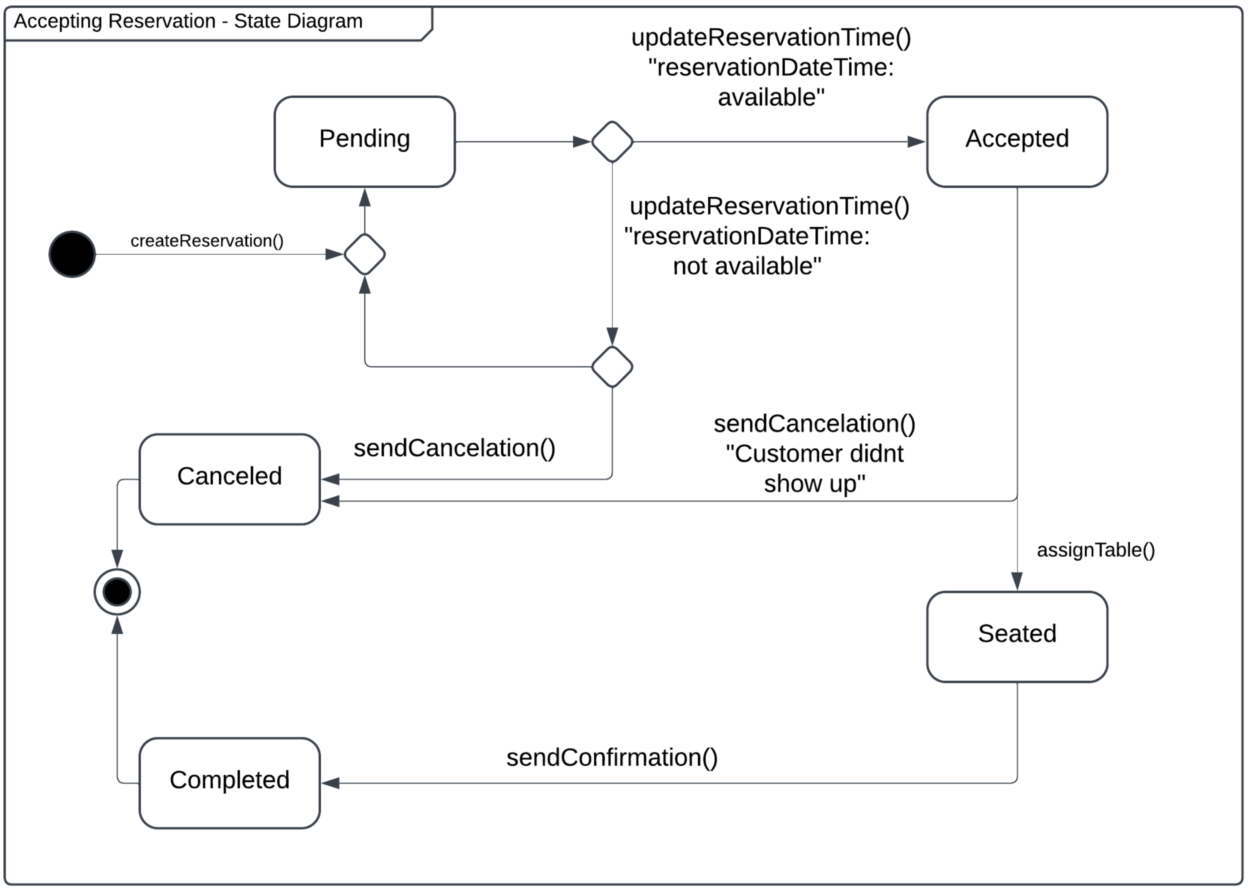
- Reverse Association: Between MenuItem and Ingredient classes.
  - **From MenuItem to Ingredient**:
    We add the ingredient to the menu item's list of ingredients. Moreover, we also update the ingredient's list to include the menu item.

  - **From Ingredient to MenuItem**:

When we remove an Ingredient from a MenuItem, you remove it from the menu item's list. In addition, we also update the ingredient's list to remove the menu item.

- Shortly, it allows us to access related objects from either side of the relationship easily.
  1. We can find all ingredients used in a menu item.
  2. We can find all menu items that use a specific ingredient.

STATE DIAGRAM


Accepting Reservation - State Diagram
Pending
Accepted
createReservation()
updateReservationTime() "reservationDateTime: available"
updateReservationTime() "reservationDateTime: not available"
Canceled
sendCancelation()
sendCancelation() "Customer didnt show up"
assignTable()
Seated
Completed
sendConfirmation()

State Diagram - Design Description

The state diagram describes the state of accepting the reservation in the system. When using createResererervation() method, a new Reservation object is created with the status of “Pending”. Depending whether there are dates/times available for the reservation and whether the client decides to change the date there are 3 possible states that the Object can be assigned to.

1.”**Accepted**” - In case if there is suitable DateTime
2.”**Cancelled**” - If there are no suitable dates
3.”**Pending**” - If the client decides to reschedule the reservation

Once the reservation enters the accepted state, further modifications are done to it using either assignTable() method, if the client showed up, or sendCancelation(), if the client didn't show up for his scheduled time:
1.”**Seated**” - If the client showed up
2.”**Cancelled**” - If the client didn't show up
3.”**Completed**” - By invoking sendConfirmation() method

The state of the object can end in two ways. Either as “Complete” or “Cancelled”. If canceled the object should be removed thus the reservationDateTime tied to it, should be available again.

General Association Implementation

Add Method:

The Add method ensures that a new item can be added to the associated collection. It begins by validating the input to ensure it is not null. If the item does not already exist in the collection, it is added. To maintain the integrity of the bidirectional association, a reverse connection is established by calling the appropriate method (e.g., SetParent) on the added item.

Remove Method:

The Remove method facilitates the removal of an item from the associated collection. It validates the input to ensure the item exists within the collection. Once validated, the item is removed from the collection. To maintain consistency in the bidirectional association, the reverse connection is updated by calling the appropriate method (e.g., RemoveParent) on the removed item.

Change/Modify Method:

The Change or Modify method allows the replacement of an existing item in the associated collection with a new one. It begins by validating both the old and new items to ensure they are valid and meet the required conditions (e.g., the old item exists, and the new item does not already exist in the collection). The method removes the old item using the Remove method and then adds the new item using the Add method. This process ensures that both the collection and the reverse association remain consistent.

Reflexive Association

Implementation:

In the case of reflexive associations, the relationship occurs within the same class. In this implementation, the `Staff` class manages a hierarchical relationship where each instance can act as a `supervisor` or `subordinate`. Reflexive associations are implemented using the following methods:

- **`AssignSupervisor`**: This method assigns a supervisor to the current staff member. It ensures the input is valid and avoids circular references by checking that the staff member is not attempting to supervise itself. Existing relationships are removed if necessary, and a bidirectional connection is maintained by assigning the reverse subordinate relationship in the supervisor.

- **`RemoveSupervisor`**: This method removes the current supervisor from the staff member. It ensures that the bidirectional link is consistently updated by invoking the `RemoveSubordinate` method on the supervisor.

- **`AssignSubordinate`**: This private method assigns a subordinate to the staff member. It validates inputs and removes any pre-existing subordinate relationship before establishing the new one. The bidirectional connection is maintained by calling `AssignSupervisor` on the subordinate.

- **`RemoveSubordinate`**: This private method removes the current subordinate from the staff member. The bidirectional connection is updated by invoking `RemoveSupervisor` on the subordinate.

Differences from Basic Association:

1. **Same Class Relationship**:

   a. Reflexive associations are contained within a single class (`Staff`), whereas basic associations typically involve two distinct classes.

2. **Bidirectional Role Assignment**:

   a. In reflexive associations, roles (e.g., supervisor and subordinate) are explicitly defined within the same class, requiring careful management of bidirectional links.
   b. In basic associations, roles are defined by the relationship between two different classes.

3. **Circular Dependency Prevention**:

    a. Reflexive associations require additional checks to prevent self-referential relationships or circular dependencies (e.g., a staff member cannot supervise themselves or create loops).

4. **Association Placement**:

    a. In reflexive associations, both ends of the relationship (e.g., supervisor and subordinate) are managed within the same class using properties or fields.
    b. In basic associations, each class independently defines its role in the relationship.

Association Class/Attribute

Implementation:

In the case of an association class or attribute, an intermediate class (or attribute) is used to represent the relationship between two other classes. In this implementation, the association between `Payment` and `PaymentMethod` is managed explicitly, allowing additional functionality or attributes to be added to the relationship.

- **`SetPaymentMethod`**: This method assigns a `PaymentMethod` to a `Payment` instance. It validates that the provided `PaymentMethod` is not null and establishes the relationship. To maintain bidirectional consistency, it also ensures that the `Payment` instance is added to the `PaymentMethod`'s collection of associated payments.

- **`RemovePaymentMethod`**: This method removes the association between a `Payment` and its `PaymentMethod`. It checks whether the current `Payment` has an assigned `PaymentMethod` and removes the bidirectional link by invoking `RemovePayment` on the associated `PaymentMethod`.

- **`AddPayment`**: This method, implemented in the `PaymentMethod` class, establishes the reverse relationship by adding a `Payment` to the `PaymentMethod`'s collection. It ensures that the `Payment` instance is valid and not already associated before adding it. To maintain bidirectional consistency, it also calls `SetPaymentMethod` on the `Payment`.

- **`RemovePayment`**: This method removes a `Payment` from the `PaymentMethod`'s collection. It validates the `Payment` instance and ensures bidirectional consistency by invoking `RemovePaymentMethod` on the `Payment`.

- **`UpdatePayment`**: This method replaces an old payment with a new one in the `PaymentMethod`'s collection. It validates the inputs, ensures the old payment exists and the new payment does not, and uses the `RemovePayment` and `AddPayment` methods to update the relationship. The bidirectional connections are automatically updated during this process.

Differences from Basic Association:

1. **Intermediate Class Handling**:

    a. Association classes like `PaymentMethod` add an intermediate layer to the relationship, which can include additional logic, attributes, or methods.
    b. Basic associations directly link two classes without an intermediate class.

2. **Additional Attributes or Methods**:

    a. The association class (`PaymentMethod`) can include extra attributes (e.g., payment-specific details) or methods (e.g., filtering payments by criteria). This flexibility is not present in basic associations.

3. **Bidirectional Management**:

    a. The association class must manage both directions of the relationship explicitly, ensuring

   consistency between the associated objects.
   b. In basic associations, only the relationship between two classes is managed.

4. **Update Logic**:

   a. For association classes, updating the relationship involves modifying the intermediate class and ensuring bidirectional consistency.
   b. Basic associations typically update directly between the two classes involved.

Handling the Extra Class:

To handle the association class (`PaymentMethod`), the following approach is used:

- The association class manages collections of related objects (e.g., payments) and provides methods for adding, removing, and updating these relationships.
- The related class (`Payment`) manages its link to the association class and invokes corresponding methods on the association class to maintain bidirectional consistency.
- This structure ensures encapsulation and separation of concerns, as each class is responsible for managing its part of the relationship.

Qualified Association

Implementation:

A **qualified association** is a relationship where one class is associated with another through a unique key or attribute that ensures a specific mapping between the objects. In this implementation, the association between `Reservation` and `Table` is qualified by the `ReservationDateTime`. Each table maintains a unique set of reservations, qualified by the reservation's date and time, ensuring no conflicts arise.

Key Methods:

1. **`SetTable` (Reservation class)**:

   a. This method associates a `Reservation` with a `Table`. It ensures:
      i. Any existing table association is removed before establishing a new one.
      ii. The `ReservationDateTime` of the new reservation is unique within the table's current reservations.
   b. If the `ReservationDateTime` conflicts with another reservation in the new table, an exception is thrown.
   c. A bidirectional link is maintained by calling the `AddReservation` method on the `Table`.

2. **`RemoveTable` (Reservation class)**:

   a. This method removes the association between a `Reservation` and its `Table`, ensuring the bidirectional link is updated by calling `RemoveReservation` on the `Table`.

3. **`AddReservation` (Table class)**:

   a. Adds a `Reservation` to the table's list of reservations.
   b. Ensures that the `ReservationDateTime` is unique for all reservations in the table. If a conflict exists, an exception is thrown.
   c. Maintains bidirectional consistency by calling the `SetTable` method on the `Reservation`.

4. **`RemoveReservation` (Table class)**:

   a. Removes a `Reservation` from the table’s list of reservations and ensures the reverse association is updated by calling `RemoveTable` on the `Reservation`.

5. **`UpdateReservation` (Table class)**:

    a. Updates an existing reservation in the table by replacing it with a new one.
    b. Checks for potential conflicts in the `ReservationDateTime` within the table before making changes.
    c. The old reservation is removed using `RemoveReservation`, and the new reservation is added using `AddReservation`.

Differences from Basic Association:

1. **Key/Qualifier Usage**:

    a. In a qualified association, a unique attribute (`ReservationDateTime`) is used to enforce constraints on the relationship.
    b. Basic associations do not involve such qualifiers and treat all objects in the relationship equally.

2. **Conflict Management**:

    a. In a qualified association, methods enforce uniqueness and prevent conflicts (e.g., ensuring no two reservations have the same `ReservationDateTime` for the same table).
    b. Basic associations do not typically enforce such constraints.

3. **Enhanced Validation**:

    a. Methods in qualified associations include additional logic to validate the qualifier (e.g., `ReservationDateTime`) before establishing or modifying the association.
    b. Basic associations generally only check for null values or duplicates.

Composition Implementation

Explanation:

In composition, the component (`OrderItem`) cannot exist independently of the composite (`Order`). The composite is responsible for creating, managing, and deleting the components. If the composite is deleted, the components are also deleted.

1. **`CreateOrderItem` (Order Class)**:

    a. This method creates a new instance of `OrderItem` and immediately adds it to the `Order`.
    b. The creation of `OrderItem` is controlled entirely by the `Order` class, reflecting a key characteristic of composition: the composite class manages the lifecycle of its components.

2. **`AddOrderItem` (Order Class)**:

    a. This private method adds an existing `OrderItem` to the `Order`.
    b. It ensures the `OrderItem` is not null and is not already part of the `Order`.
    c. While composition typically involves components created by the composite, this method provides flexibility by allowing external items to be added.

3. **`RemoveOrderItem` (Order Class)**:

    a. This method removes an `OrderItem` from the `Order`.
    b. Since `OrderItem` is tightly bound to `Order`, its removal from the composite effectively removes it from existence in the application's logical model. No further cleanup is necessary because `OrderItem` cannot exist without its `Order`.

Differences from Basic Association:

1. **Lifecycle Control**:

    a. In composition, the composite (`Order`) fully controls the lifecycle of the component (`OrderItem`). The component cannot exist independently or be shared across multiple composites.
    b. In basic associations, objects in the relationship can exist independently, and their lifecycles are not tied to each other.

2. **Dependency**:

    a. In composition, the component is dependent on the composite. If the composite is destroyed, the component is destroyed as well.
    b. In basic associations, objects are not dependent on each other's existence.

3. **Method Restrictions**:

    a. Composition often includes methods to create and manage components directly within the composite (e.g., `CreateOrderItem`).