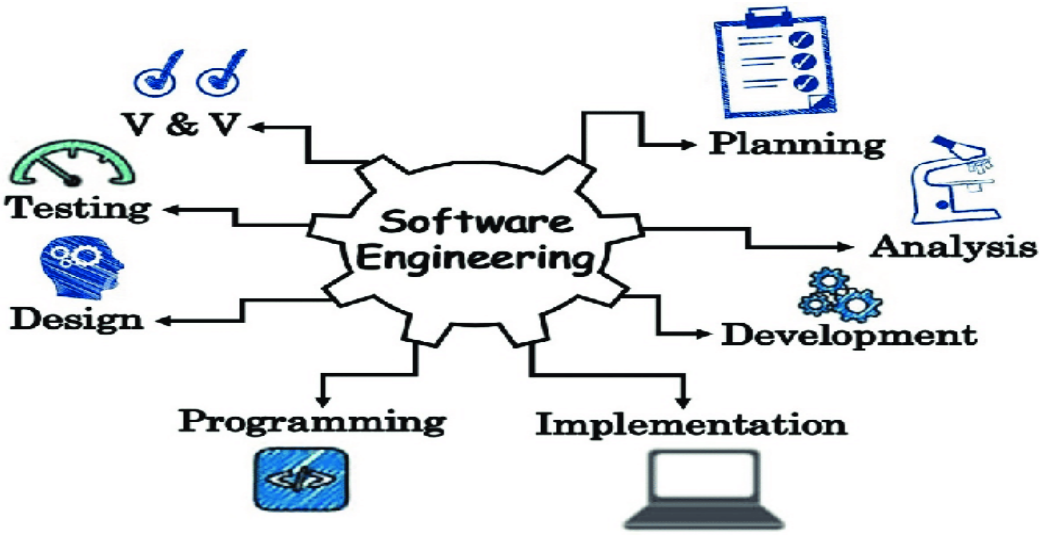

Software Engineering 2 Assignment

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Introduction

In the domain of software engineering, the efficacy and elegance of a system's design are paramount. It is within this context that our project led by Aaron Baggot and Aniket Bedade, focuses on enhancing and refining the existing USE model for a restaurant management system. The restaurant industry, with its complex dynamics involving customer interactions, table management, and payment processing, offers ample opportunities to explore various software engineering principles and methodologies.

Our main goal is to expand the functionality of the restaurant management system while maintaining a strong emphasis on coupling and cohesion principles. By introducing new features such as table reservation and dynamic table allocation, we aim to improve the system's flexibility and usefulness. Additionally, we aim to implement a robust payment system to ensure secure and efficient transaction handling.

At the heart of our approach lies the concept of design by contract, where each component of the system is equipped with preconditions, postconditions, and invariants. These contractual specifications serve as guidelines for the system's behaviour and facilitate thorough testing and validation. Through the use of OCL (Object Constraint Language) contracts, we define precise conditions for invoking operations, ensuring the system's reliability and resilience.

We employ a comprehensive methodology that includes class diagrams, sequence diagrams, state machines, and object diagrams to gain insights into the system's structure, behaviour, and interactions. Each of these artifacts contributes to a thorough analysis and refinement process. Additionally, we integrate testing mechanisms such as pre- and post-operation procedures to validate system constraints and operation behaviour rigorously.

Throughout this project, we provide a detailed exploration of the extended USE model, explaining the rationale behind each design decision and offering a comprehensive assessment of the system's functionality. By adhering to industry standards and utilizing advanced software engineering techniques, our aim is to develop restaurant management systems that are robust, scalable, and user-centric, exemplifying the highest standards of software engineering excellence.

Restaurant Selection and Use Case Scenarios

In the realm of software engineering, creating systems that are both efficient and robust is essential. This report outlines the process of enhancing and refining the current USE model for a restaurant management system. The focus is on key functionalities such as booking reservations, handling walk-ins, and managing cancellations, all while integrating state machines and pre/post conditions. Through the exploration of various software engineering principles and methodologies, the aim is to improve the system's functionality and user experience.

As part of this project, additional use case scenarios have been incorporated to broaden the system's capabilities. These include features such as table reservation, dynamic table allocation, and payment processing. These scenarios offer a comprehensive view of how the system interacts with users and enhances its overall usability.

Make Reservation

This scenario involves customers reserving tables for dining at the restaurant. Customers provide personal details, select the date, time, and number of guests, and either choose a preferred table or allow the system to assign one. Upon confirmation, a reservation is created, and the customer receives a confirmation message.

Record Walk-In

In this scenario, customers arrive at the restaurant without prior reservations. The waitstaff checks table availability, assigns an available table to the customer, and seats them. This walk-in is then recorded in the system for tracking purposes.

Cancel Reservation

This scenario allows customers to cancel their existing reservations. After logging into the system, customers navigate to the reservation management section, select the reservation to cancel, and confirm the cancellation. Once cancelled, the reserved table becomes available for other customers.

Associations

The associations in the restaurant booking system defines the relationships between various entities within the system. These associations play a crucial role in modelling the interactions and dependencies between different components. Below is an overview of the associations:

IsAt

This association links bookings to tables, representing the relationship between reservations and the tables they are assigned to. Each booking (reservation) is associated with one table, indicating where the customers will be seated.

Makes

The Makes association establishes a connection between customers and their reservations. It signifies that each reservation is made by a specific customer, capturing the relationship between customers and their bookings.

Talking

The Talking association connects receptionists with walk-in bookings. It denotes the current interaction between a receptionist and a walk-in customer, indicating which walk-in customer the receptionist is currently assisting.

Checks

This association links receptionists to tables, indicating the tables that a receptionist is responsible for managing. It represents the association between receptionists and the tables they oversee.

Contains

The Contains association ties the booking system to the current booking. It signifies that the booking system contains the current booking being processed or managed, providing a reference to the active booking within the system.

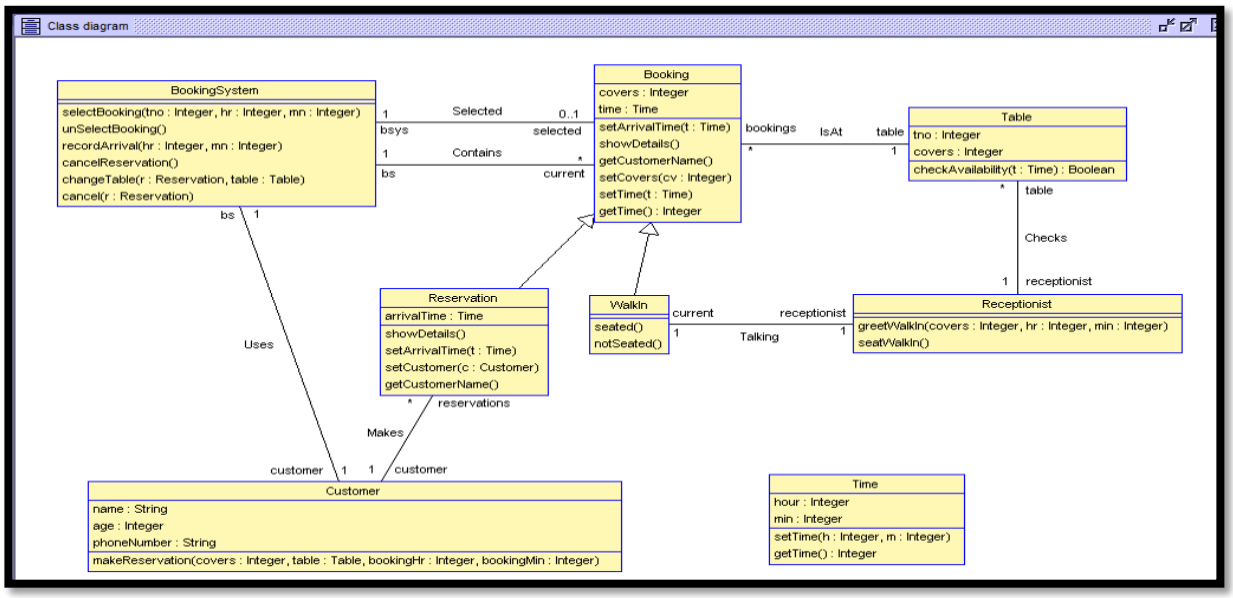
Selected

The Selected association connects the booking system to the selected booking. It represents the relationship between the booking system and the booking that is currently selected or highlighted for further actions or modifications.

Uses

The Uses association establishes a relationship between the booking system and the customer. It indicates that the booking system is utilized by a specific customer, highlighting the association between customers and the system they interact with.

These associations facilitate the organization of data and operations within the restaurant management system, enabling efficient communication and management of reservations, customers, receptionists, and tables.



Class Diagram with soil implementation

The SOIL code essentially creates and links different objects to form a booking system for a restaurant. Creating various objects representing different aspects of the booking system, such as the BookingSystem itself, different types of bookings like WalkIn and Reservation, as well as entities like Customer, Table, and Time. These objects are like instances of classes and hold specific information related to bookings, customers, tables, and time.

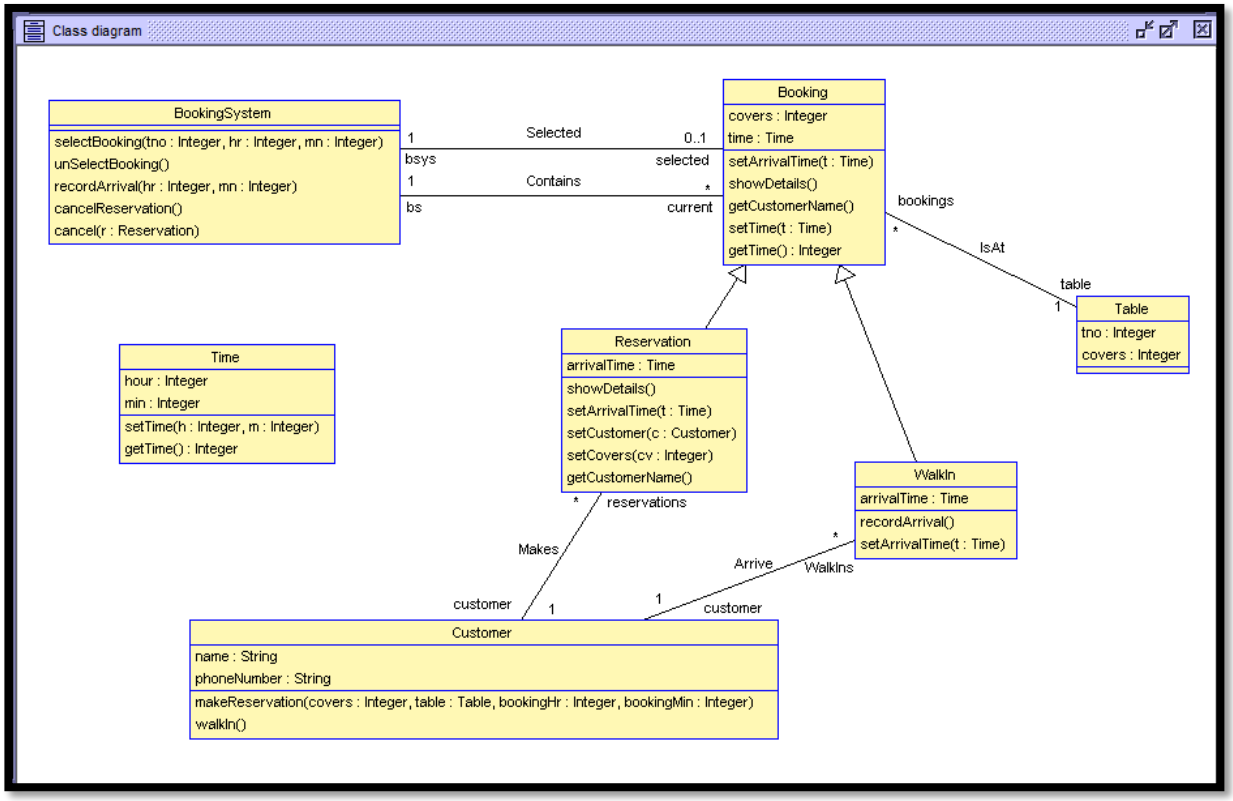
Once these objects are created, the code sets specific attributes for each of them. For example, attributes like covers (number of people), time, name, age, phone number, and table number are assigned values to represent the characteristics of each instance.

After creating and configuring these objects, the code establishes connections or relationships between them. For instance, it links bookings with tables using the IsAt association, connects customers with reservations through the Makes association, records walk-ins with customers via the Arrive association, and links the booking system with its contained bookings using the Contains association.

The provided code constructs a functional booking system for a restaurant. It allows for the creation and management of various bookings, both reservations and walk-ins, enables customers to interact with the system, assigns tables to bookings, and organizes the overall booking process. This system is structured with different components like classes, operations, and constraints, ensuring a robust and comprehensive solution for managing restaurant bookings.

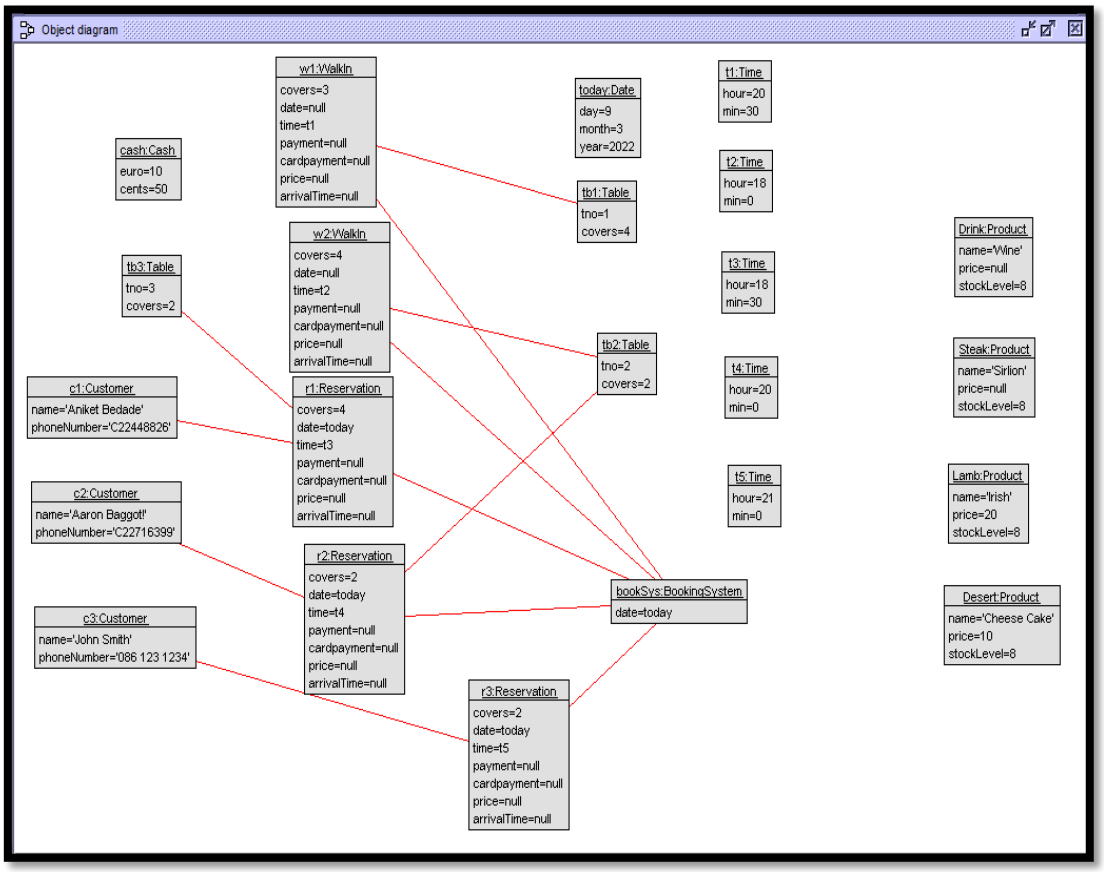
Class Diagram

A class diagram is a type of static structure diagram in UML (Unified Modelling Language) that represents the structure of a system by showing the system's classes, their attributes, operations, and relationships.



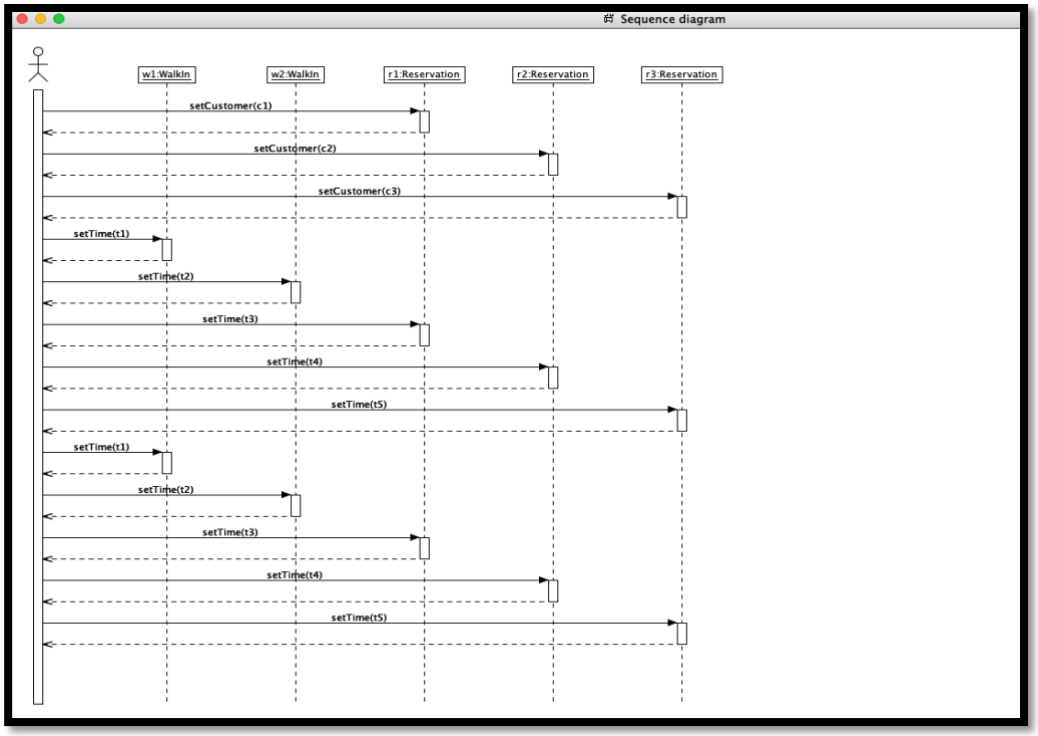
Object Diagram

An object diagram in USE represents a snapshot of the system at a specific moment, showing instances of classes and their relationships. It illustrates how objects interact and collaborate within the system, providing a visual depiction of runtime behaviour. Object diagrams help in understanding the runtime structure of the system and can be used to verify system design and implementation.



Sequence Diagram

A sequence diagram in USE illustrates the interactions between different objects or components of a system over time. It shows the flow of messages between objects, indicating the order in which interactions occur. Sequence diagrams help visualize the dynamic behavior of a system, depicting how objects collaborate to achieve specific functionalities or scenarios.



BookingSystem

Represents the main control class responsible for managing bookings, including selecting, unselecting, recording arrivals, cancelling reservations, and changing tables.

Booking:
Represents a generic booking with attributes such as the number of covers and time.
WalkIn:
Represents a walk-in booking, which inherits from Booking and includes additional operations specific to walk-ins.
Reservation:
Represents a reservation booking, which also inherits from Booking and includes operations specific to reservations.
Customer:
Represents a customer with attributes such as name, age, and phone number, and operations for making reservations and walk-ins.
Table:
Represents a restaurant table with attributes such as table number and covers, and a query operation to check availability.
Receptionist:
Is the control class that manages walk ins.

Booking and Reservation Class

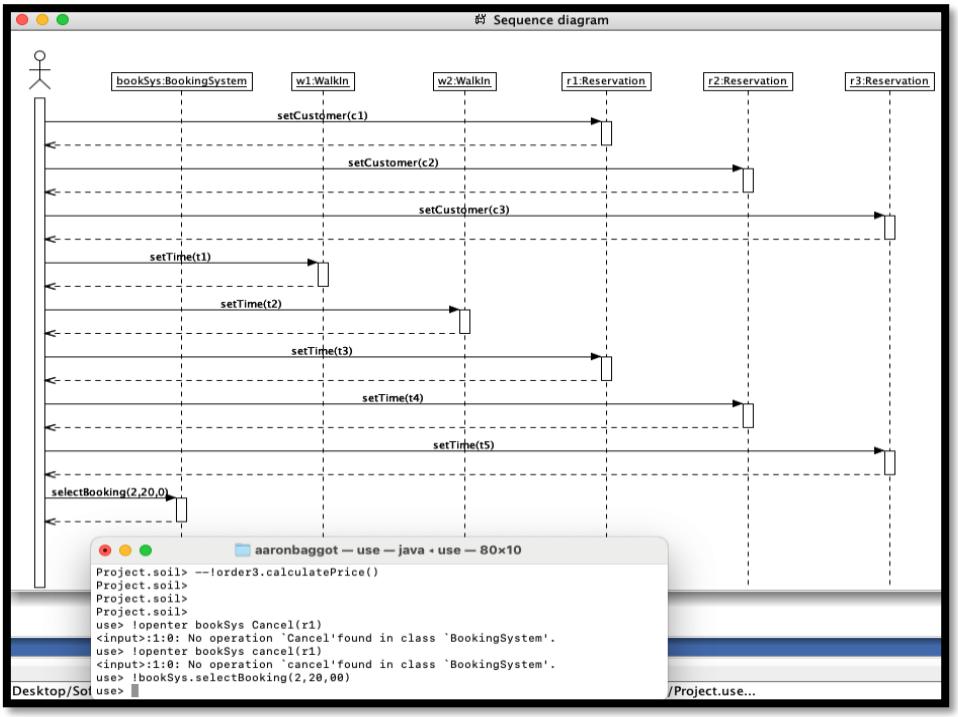
The Booking and Reservation classes represent different types of bookings, each with specific attributes and operations. State machines depict the transitions between booking states, such as new booking, waiting, and seated, providing a clear overview of the booking lifecycle.
create: Transition from the newReservation state to the waiting state when a new reservation is created.
setArrivalTime(): Transition from the waiting state to the seated state when the arrival time for the reservation is set.

Implementation

The Reservation class contains attributes to represent each state.
Operations such as create and setArrivalTime() trigger transitions between states.
When a new reservation is created, the system transitions from the newReservation state to the waiting state.
Setting the arrival time for the reservation transitions it to the seated state, indicating that the customers have been seated.

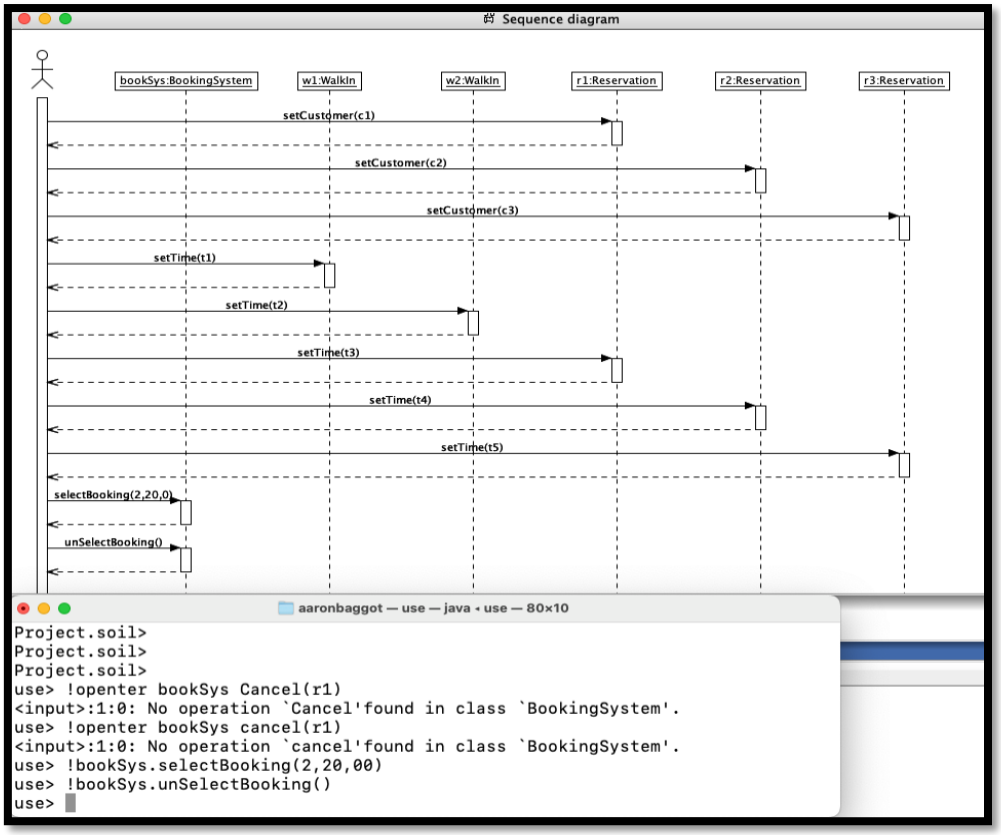
Booking System SelectBooking()

selectBooking: Selects a booking based on the table number and time provided.



Booking System unSelectBooking()

unSelectBooking: Unselects the currently selected booking.

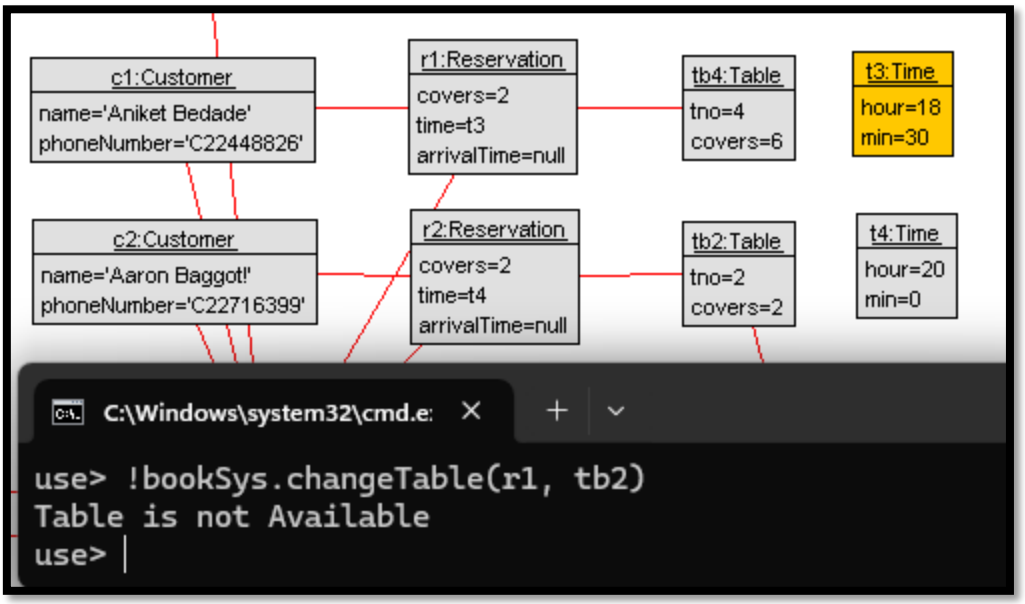


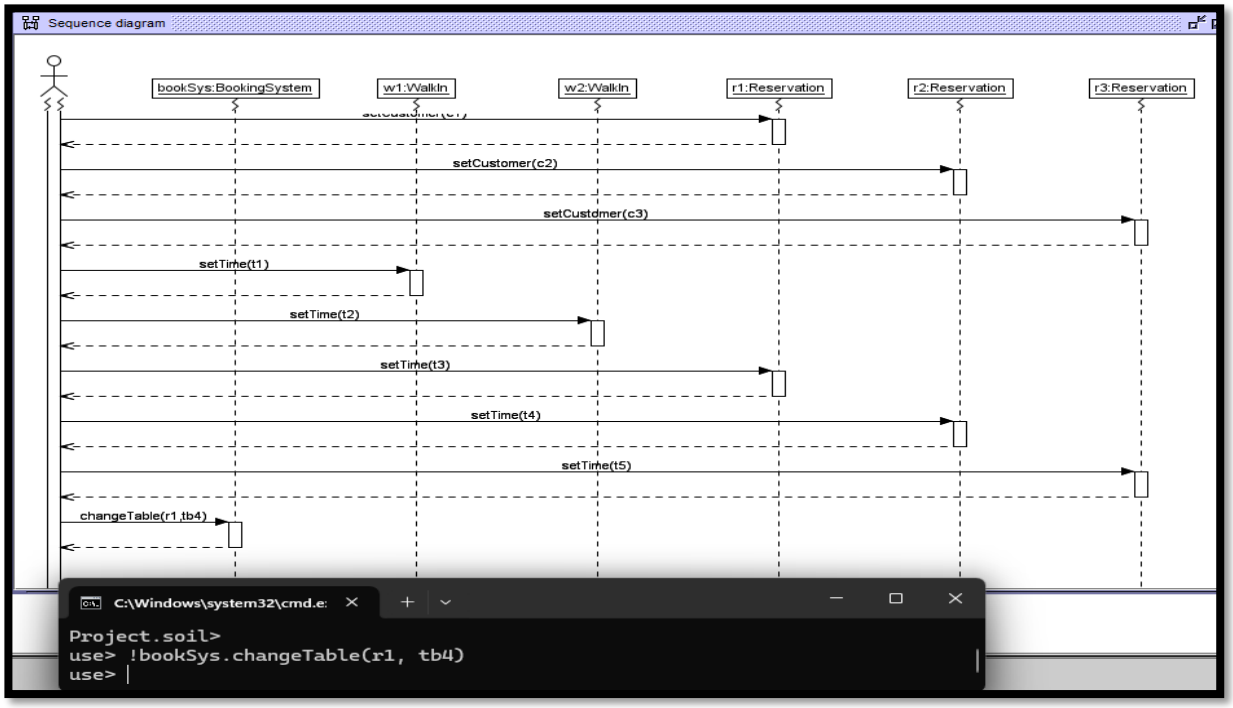
Booking System changeTable()

BookingSystem::changeTable(r : Reservation, table : Table):

Precondition (overNoOfCovers): Checks if the covers required for the booking (r.covers) are less than or equal to the covers available at the new table (table.covers). This prevents moving a booking to a table that cannot accommodate the required covers.
Precondition (Pre1): Ensures that the current table of the booking (r.table) does not include the new table (r.table->excludes(table)), meaning the booking is not already assigned to the new table.
Postcondition (Post1): Ensures that after changing the table, the new table (table) includes the booking (r.table->includes(table)).

changeTable: Changes the table for a given reservation if the new table is available.





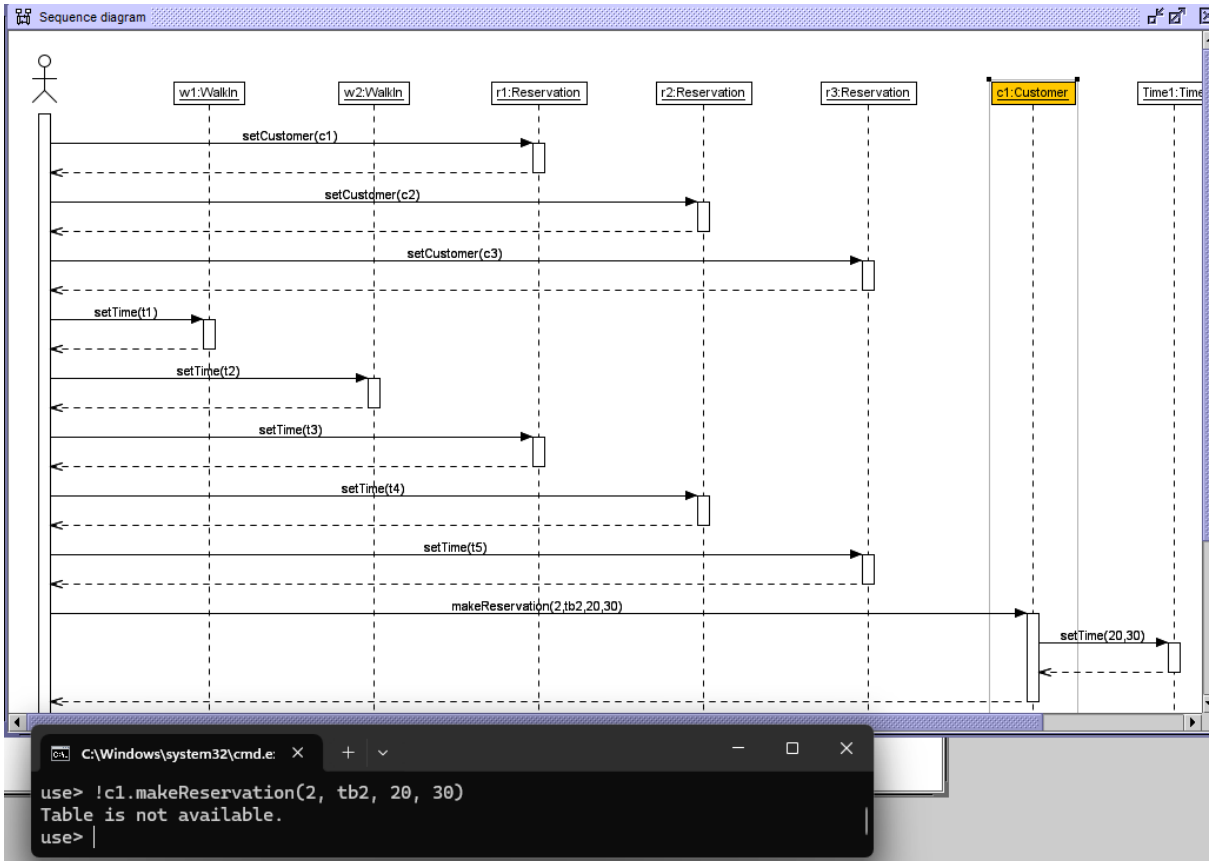
Change table condition number of covers

```
use> !bookSys.changeTable(r1, tb2)
[Error] 1 precondition in operation call `BookingSystem::changeTable(self:bookSys, r:r1, table:tb2)' does not hold:
  overNoOfCovers: (r.covers <= table.covers)
    r : Reservation = r1
    r.covers : Integer = 4
    table : Table = tb2
    table.covers : Integer = 2
    (r.covers <= table.covers) : Boolean = false

  call stack at the time of evaluation:
    1. BookingSystem::changeTable(self:bookSys, r:r1, table:tb2) [caller: bookSys.changeTable(r1, tb2)@<input>:1:0]

+-----------------------------------------------------------------+
| Evaluation is paused. You may inspect, but not modify the state. |
+-----------------------------------------------------------------+

Currently only commands starting with `?', `:', `help' or `info' are allowed.
`c' continues the evaluation (i.e. unwinds the stack).

Project.soil> Error: precondition false in operation call `BookingSystem::changeTable(self:bookSys, r:r1, table:tb2)'.
use>
```

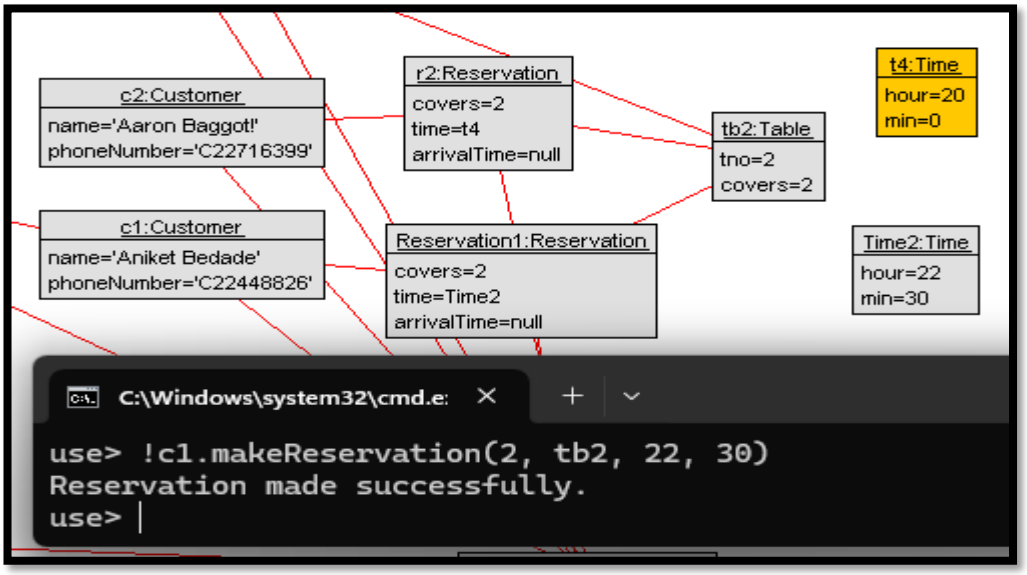
BookingSystem makeReservation()

Customer::makeReservation(covers : Integer, table : Table, bookingHr : Integer, bookingMin : Integer):

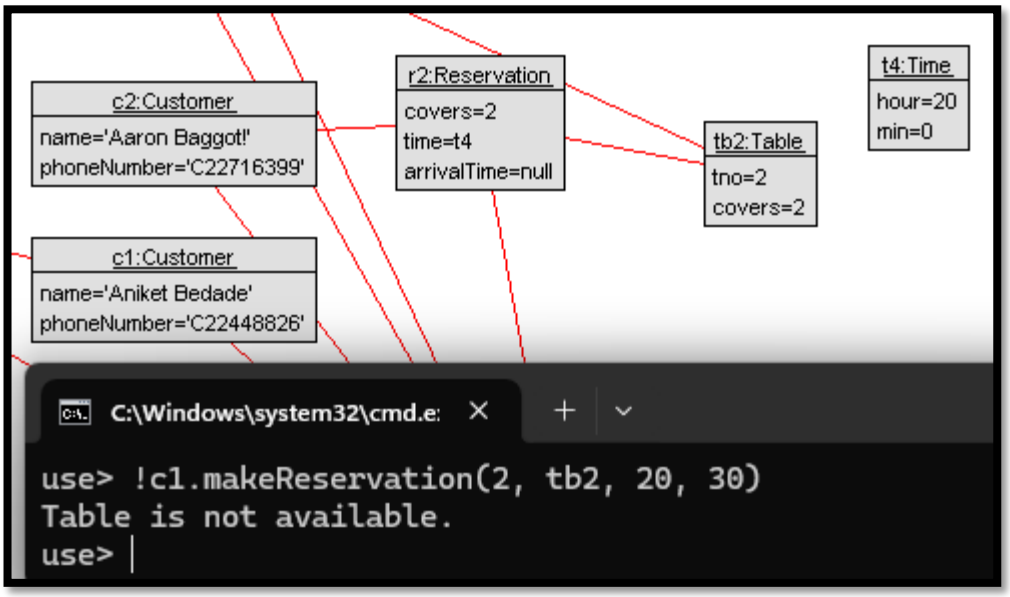
Precondition (underageBookingTime): Checks if the age of the customer (self.age) is less than 18 and if the provided booking time (bookingHr * 60 + bookingMin) is before 9:00 PM (21:00 hours). This prevents underage customers from booking tables after 9:00 PM.



The provided command !c1.makeReservation(2,tb1,18,00) represents a reservation being made within the restaurant management system. It involves making a reservation for 2 guests at table "tb1" for 6:00 PM. The output "Reservation made successfully" confirms that the reservation was successfully processed and added to the system.



No overlap when making reservation

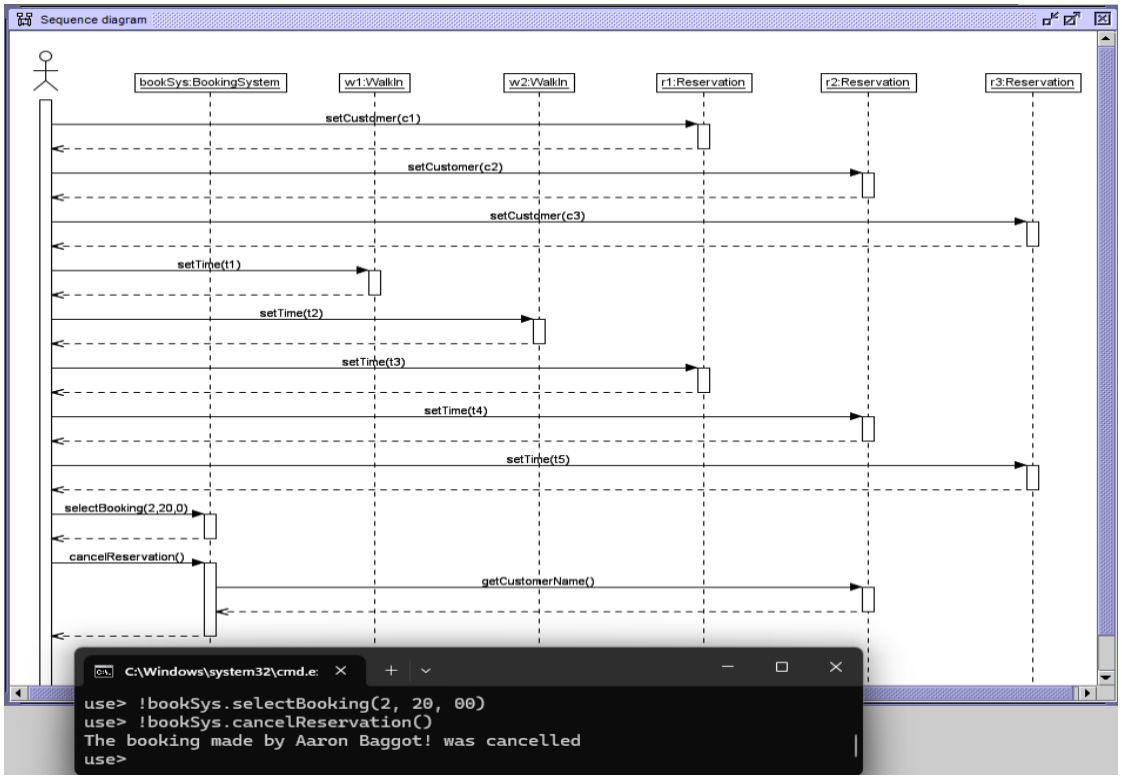


BookingSystem cancelReservation()

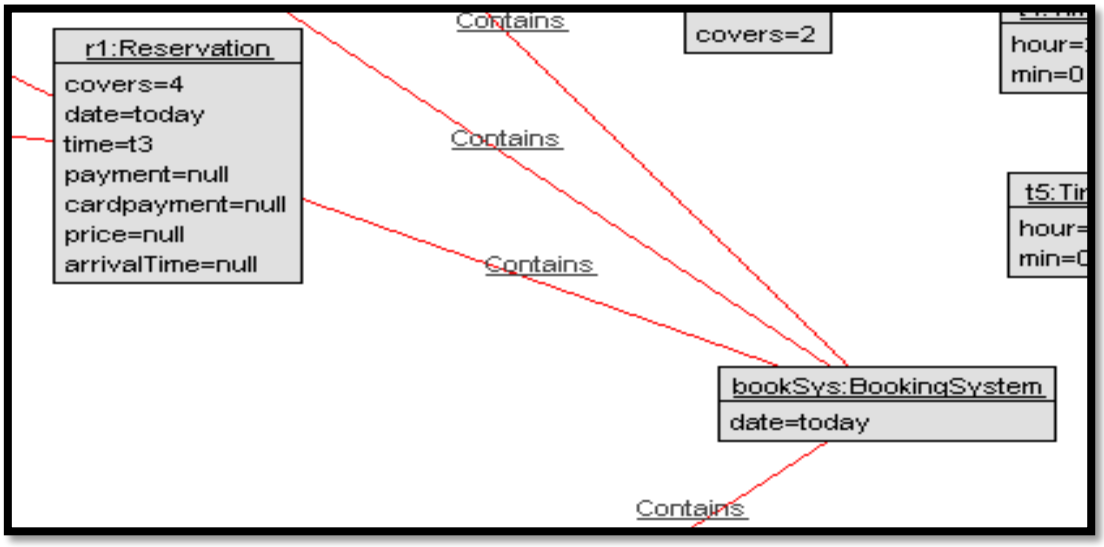
BookingSystem::cancel(r : Reservation):

Precondition (Pre1): This checks if the booking to be cancelled (r) is included in the current bookings (current->includes(r)), ensuring that only existing bookings can be cancelled.
Postcondition (Post1): This ensures that after the cancellation operation, the cancelled booking (r) is no longer included in the current bookings (current->excludes(r)).

Sequence Diagram cancel reservation



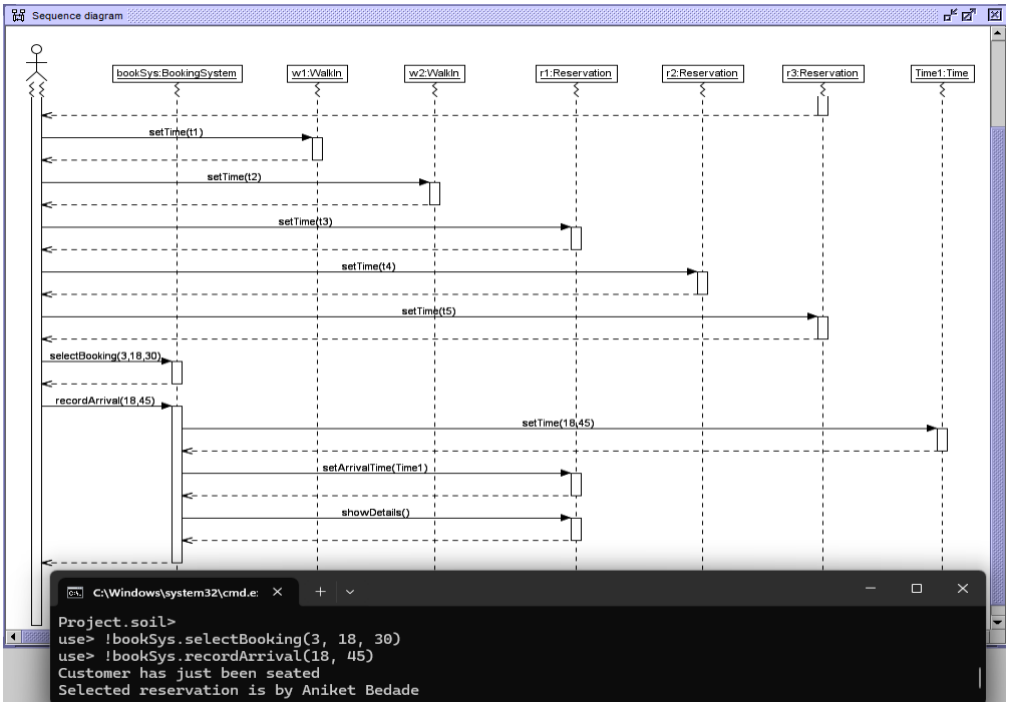
Object Diagram cancel reservation



Booking System recordArrival()

BookingSystem::recordArrival(hr: Integer, mn: Integer):

Precondition (arrivalBeforeBooking): This constraint ensures that the arrival time of the selected booking (self.selected.getTime()) is before or at the same time as the provided arrival time (mn + hr*60). This is to prevent recording an arrival time that precedes the booking time.

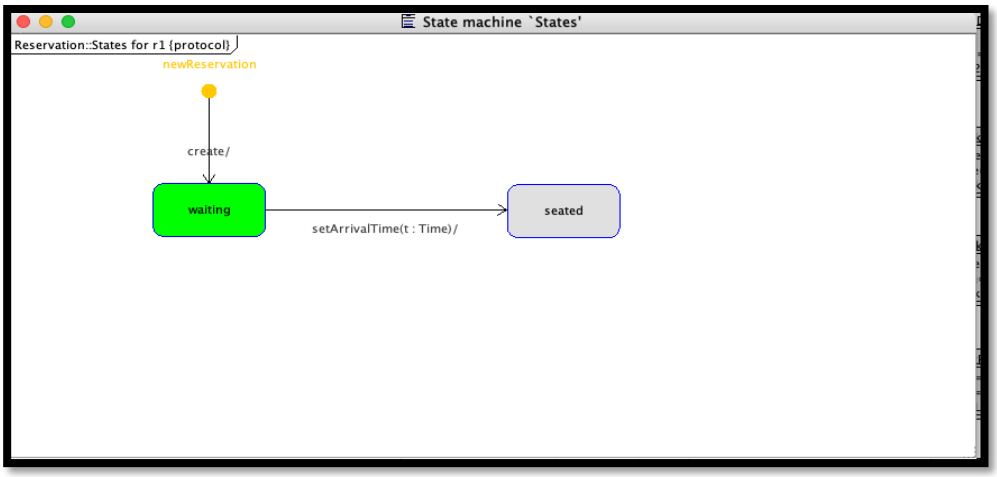


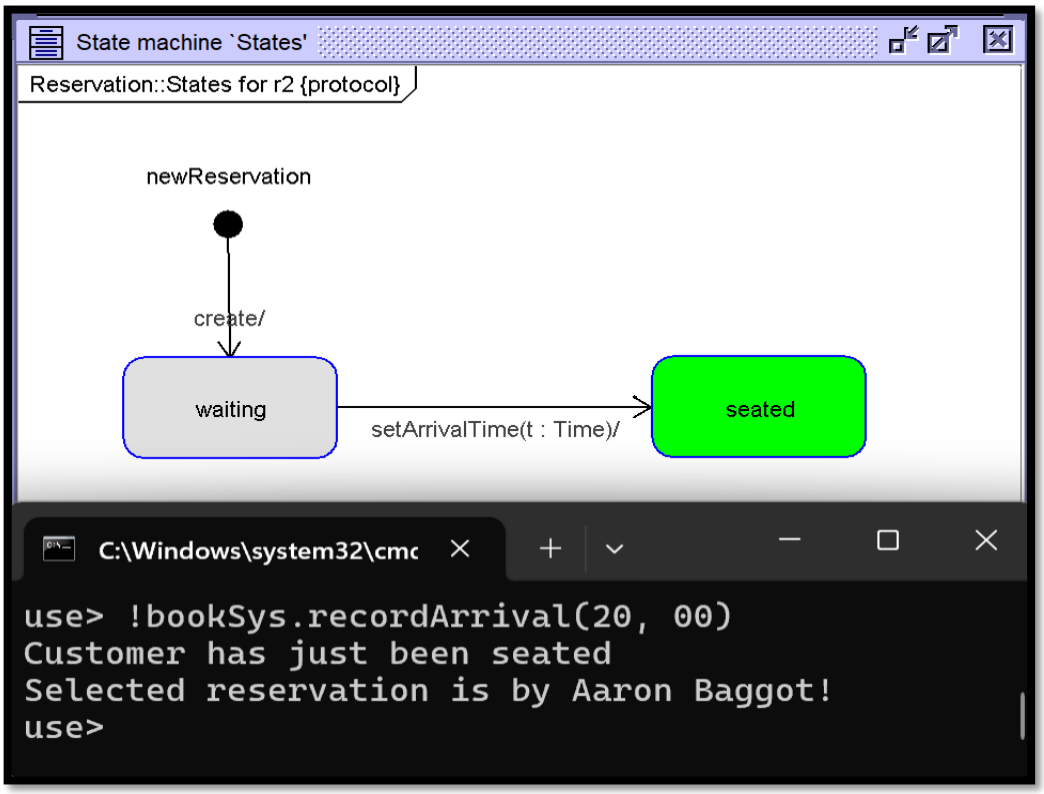
State Machine for Reservation

newReservation: Initial state when a new reservation is created.

waiting: Indicates that a reservation exists but the customers are yet to be seated.

seated: Represents a reservation where the customers have been seated.





Arrival before the booking

The test case attempts to execute the recordArrival operation on the BookingSystem object bookSys with a specified time of 17:00 (5:00 PM). However, the precondition arrivalBeforeBooking is not met, indicating that the selected booking's time (self.selected.getTime()) is not earlier than the provided time (17:00). As a result, the operation fails to execute, and an error is generated, preventing the record of the arrival.

USE Model Overview

Overview of the Unified Software Engineering (USE) modelling approach.
Explanation of how USE models will be utilized to design and test the adapted systems.

The extended USE model encompasses class diagrams, sequence diagrams, state machines, and object diagrams. Each artifact offers insights into the system's structure, behaviour, and interactions. We have meticulously defined preconditions, postconditions, and invariants for each component, ensuring a clear understanding of the system's behaviour.

Testing and Validation

In the realm of software development, where precision and reliability are paramount, testing and validation are fundamental practices. When dealing with systems outlined using Use Case UML (Unified Modelling Language) and bound by OCL (Object Constraint Language), these procedures gain heightened importance. They act as safeguards, guaranteeing that the implemented systems seamlessly align with their intended functions and specifications.
By subjecting software systems to rigorous testing against their defined use cases, developers can confirm their functional accuracy. This entails closely examining every aspect of the system's behaviour to ensure it aligns with the expectations outlined in the UML diagrams. Additionally, validation against OCL constraints confirms that the system not only operates as intended but also adheres faithfully to the specified business rules and constraints.
This combined approach to testing and validation offers numerous advantages. It allows for the early detection of defects, reducing the likelihood of costly rework later in the development process. It also contributes to enhancing the user experience by identifying and addressing usability issues at an early stage. Moreover, these procedures help mitigate risks associated with system failures or non-compliance with business requirements.

Booking System

The Booking System class manages booking operations such as selecting, unselecting, recording arrivals, and cancelling bookings. The state machine diagram illustrates the transitions between different states, providing a visual representation of the booking process.
The BookingSystem class serves as the main control unit, orchestrating various operations such as selecting bookings, recording arrivals, canceling reservations, and managing the state transitions of bookings.

SelectBooking()
Booking Management system allows customers to make reservations or walk-ins. Reservations are associated with specific customers and tables, with functionalities to set covers, record arrival times, and manage reservations.
Table Management are represented as objects with attributes such as table number and covers. The system ensures that tables are appropriately managed, transitioning between states of availability, reservation, and occupation.
Time Management class facilitates time-related operations, allowing the system to track booking times, record arrival times, and enforce constraints related to timing.
Customer Management allows customers can make reservations or walk-ins, with functionalities to specify covers, booking times, and contact information.

The Booking System class manages booking operations such as selecting, unselecting, recording arrivals, and cancelling bookings. The state machine diagram illustrates the transitions between different states, providing a visual representation of the booking process.

State Machines

State machines play a crucial role in depicting the behaviour of various components within the system. They provide a visual representation of the states that objects can occupy and the transitions between these states. In our restaurant management system, state machines are used to model the lifecycle of bookings, tables, and other entities. By delineating the possible states and transitions, we gain a deeper understanding of how these entities behave in response to different operations and events.

Booking System state machine

This state machine represents the lifecycle of a booking in the restaurant booking system.

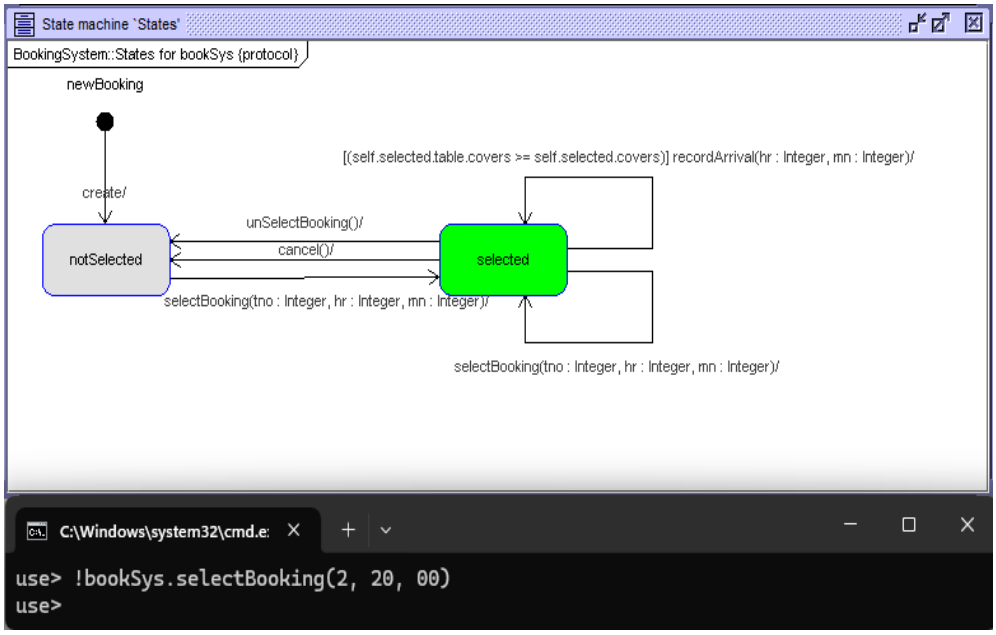
States:
newBooking: Initial state when a new booking is created.
notSelected: Indicates that a booking exists but has not been selected.
selected: Represents a booking that has been selected.
Transitions:
newBooking to notSelected: Transition when a new booking is created.
notSelected to selected: Transition when a booking is selected via the selectBooking() operation.
selected to selected: Transition when a booking is already selected and the covers of the selected table are greater than or equal to the covers of the booking, resulting in recording the arrival via the recordArrival() operation.
selected to selected: Another transition when a booking is already selected, typically after recording arrival, possibly indicating a redundant selection.
selected to notSelected: Transition when a selected booking is unselected via the unSelectBooking() operation.
selected to notSelected: Transition when a selected booking is cancelled via the cancelReservation() operation.
notSelected to notSelected: Transition when an unselected booking is cancelled via the cancel() operation.

newBooking: This is the initial state when a new booking is created.
notSelected: Indicates that a booking exists but has not been selected.
selected: Represents a booking that has been selected.

```
newBooking ->  notSelected  { create }
    selected -> selected { [self.selected.table.covers >= self.selected.covers] recordArrival() }
    selected -> notSelected { unSelectBooking() }
```

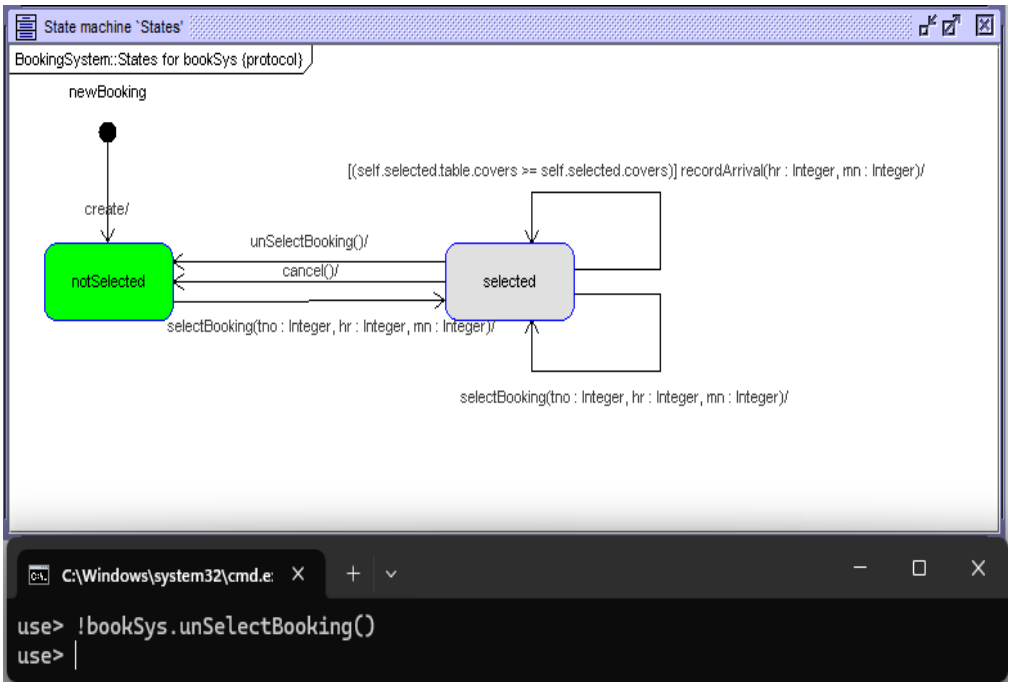
selectBooking()

selected -> selected { selectBooking() }



unselectBooking()

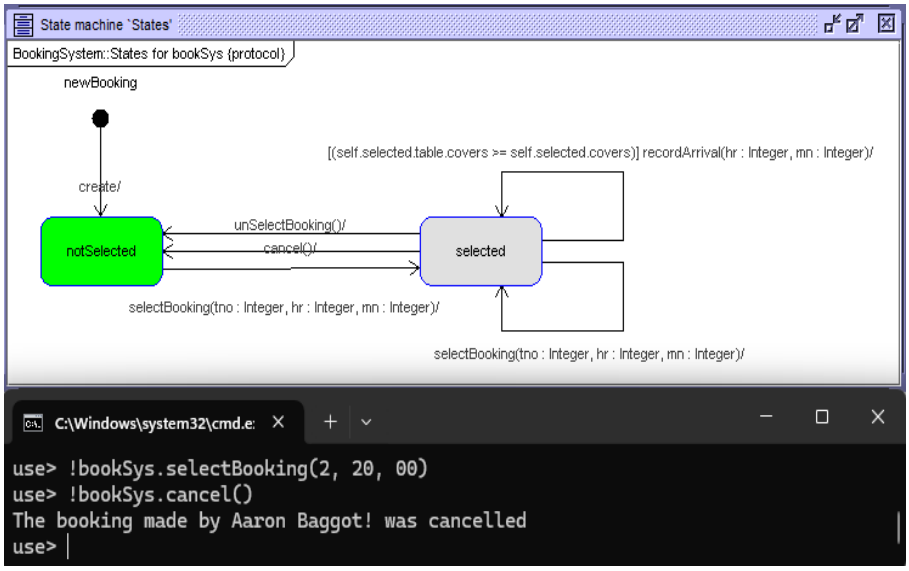
notSelected -> selected { selectBooking() }



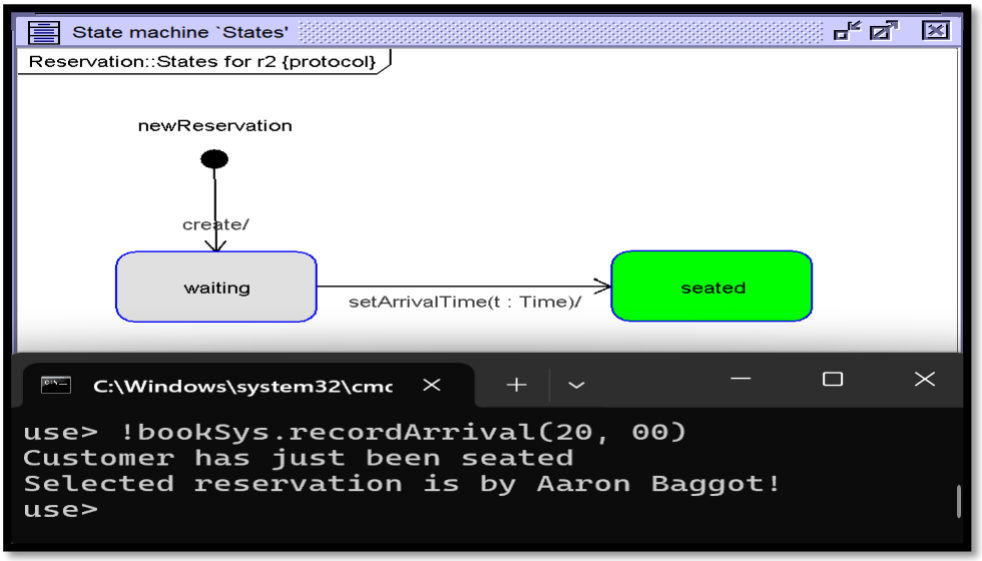
cancelBooking()

selected -> notSelected { cancelReservation() }

notSelected -> notSelected { cancel() }



Booking System Record arrival



Receptionist Operation

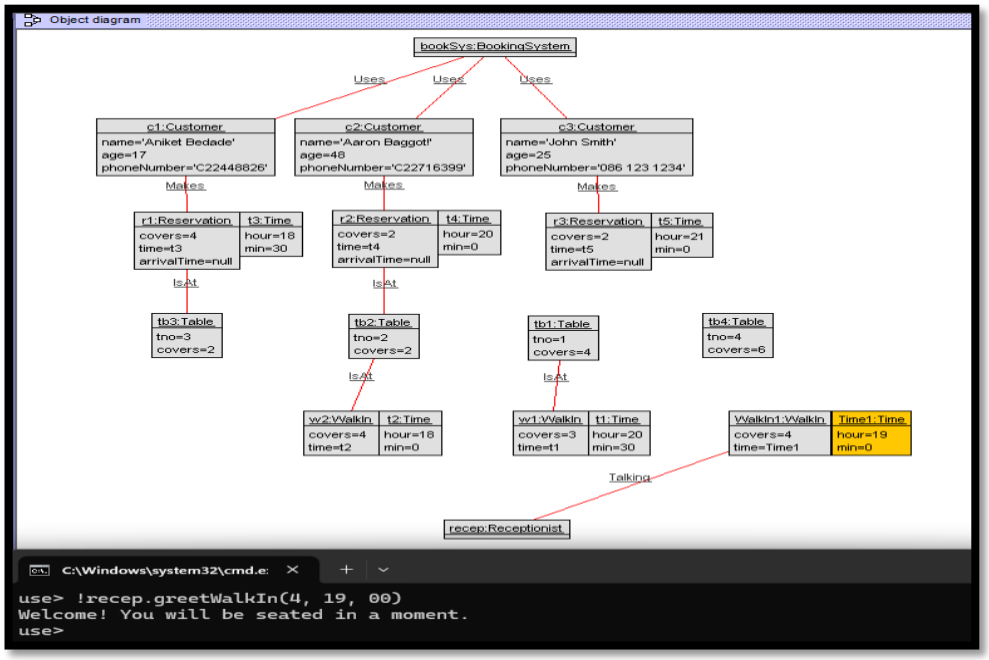
In the implemented system for a booking management system, the functionality for handling walk-in customers has been added through the creation of a receptionist class. This addition allows for seamless management of both reservations and walk-ins, ensuring efficient seating and service for all patrons. The two key operations involved in this aspect of the system are greetWalkIn() and seatWalkIn().

The greetWalkIn() operation is triggered when a walk-in customer arrives at the establishment. It instantiates a new WalkIn object, capturing details such as the number of people in the party (covers) and the current time. Subsequently, the walk-in is added to the list of customers currently being attended to, and a warm welcome message is extended.

Following the initial greeting, the seatWalkIn() operation endeavours to find an available table for the walk-in customer. This process involves iterating over each table in the receptionist's list of tables. If a suitable table is found, meeting both availability criteria at the current time and having sufficient capacity to accommodate the walk-in party, the walk-in is seated at that table. This is achieved by associating the walk-in with the selected table in the system's data model. Additionally, the walk-in's state is updated to reflect its seating status, and a message prompts the customer to take a seat. In cases where no suitable table is available, an apology message is issued, and the walk-in's status is appropriately adjusted to reflect being unseated.

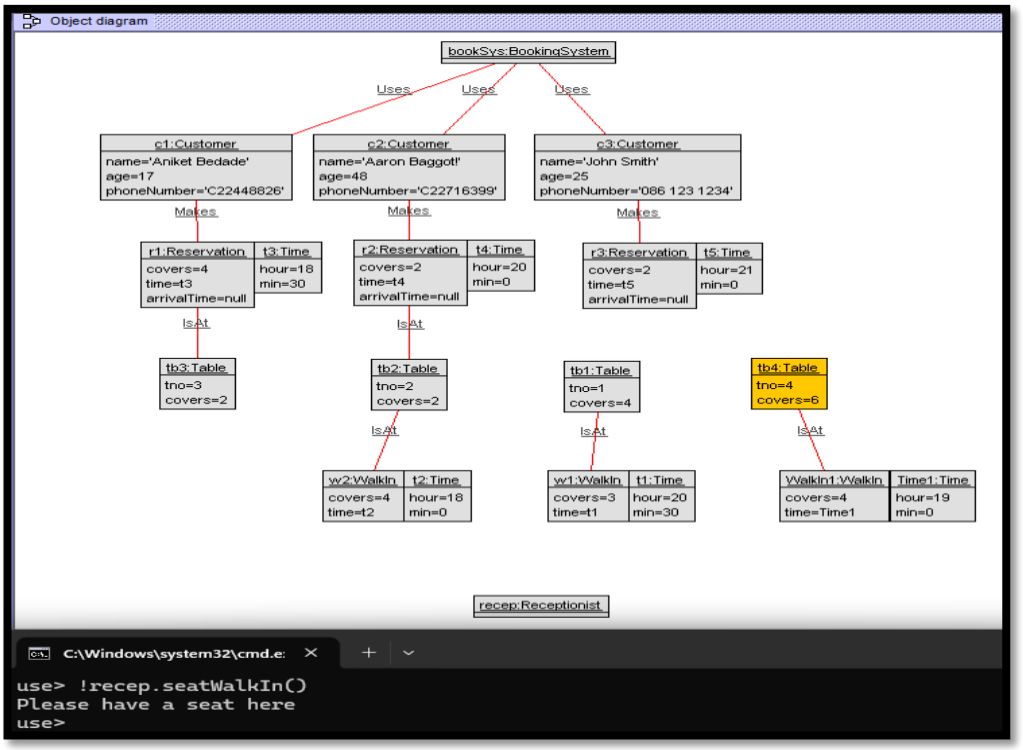
Receptionist Greet WalkIn

Receptionist greets the customer table for 4, time 7pm



Receptionist Seat WalkIn

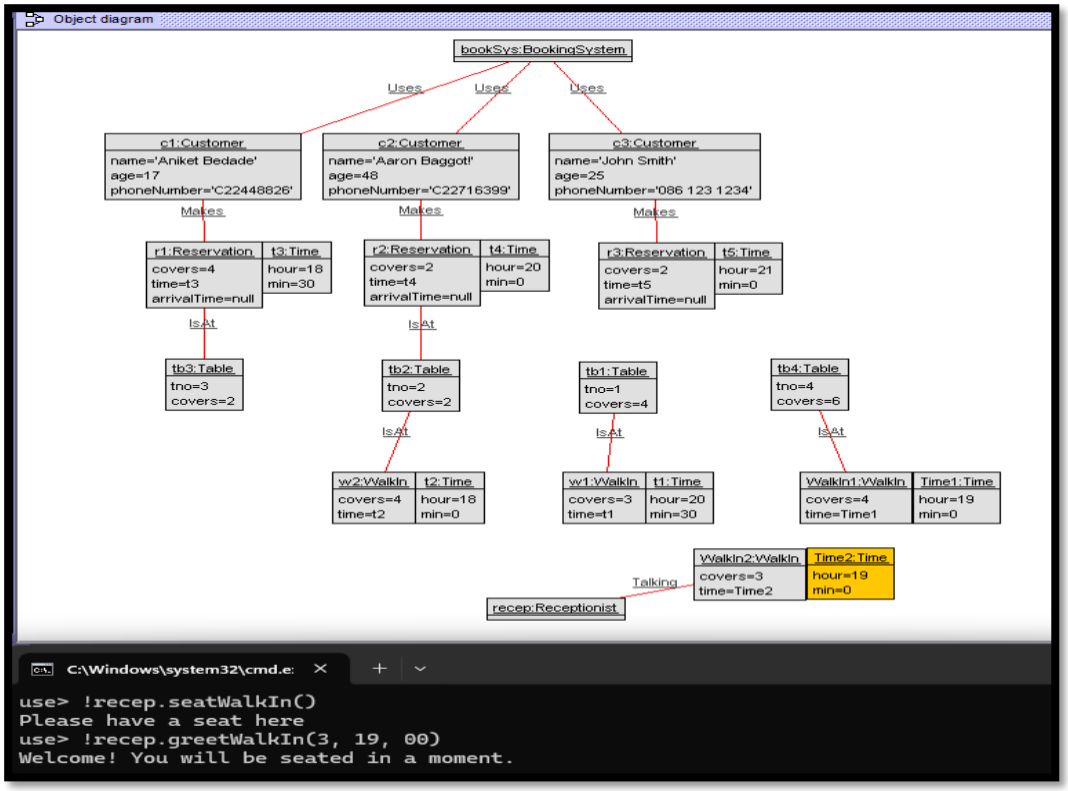
Table 4 is allocated to the customer



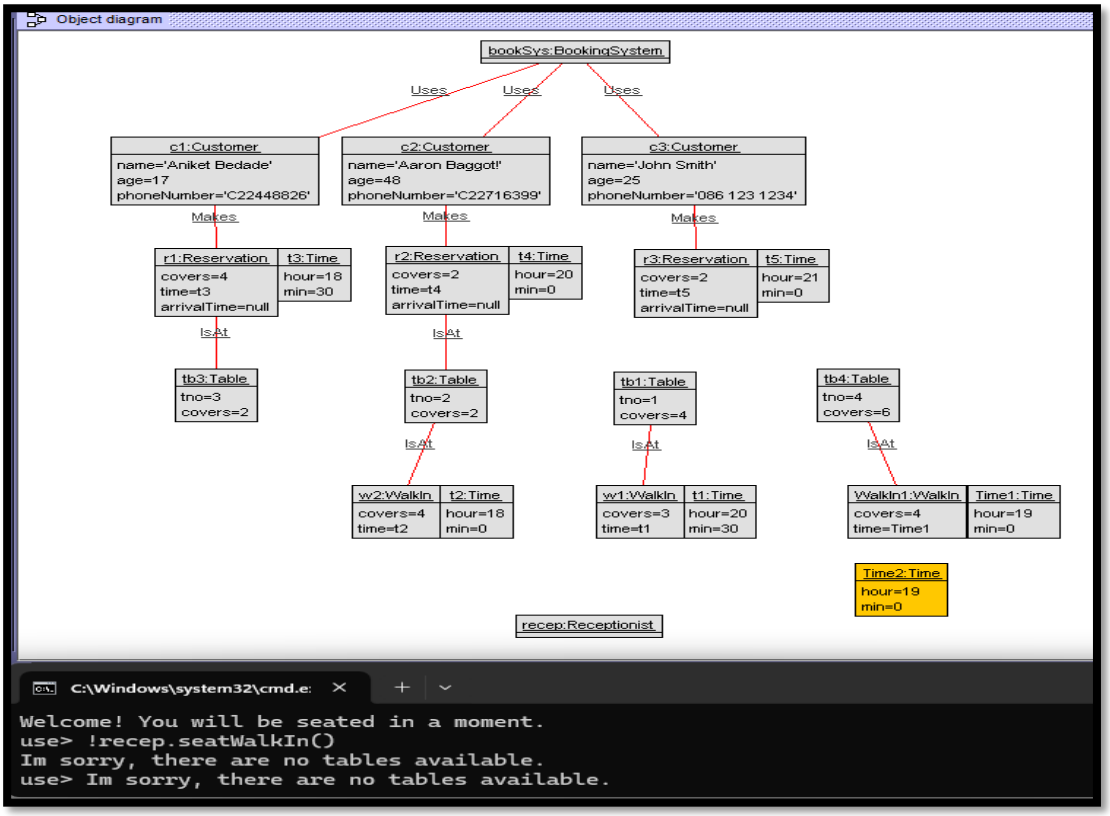
Receptionist seatWalkIn Fail

In this scenario, the receptionist welcomes a walk-in customer who wishes to book a table for three people at 7 p.m. However, upon checking the availability, it is found that all tables are already booked. As a result, the system returns a statement indicating that no tables are currently available for seating.

Part 1

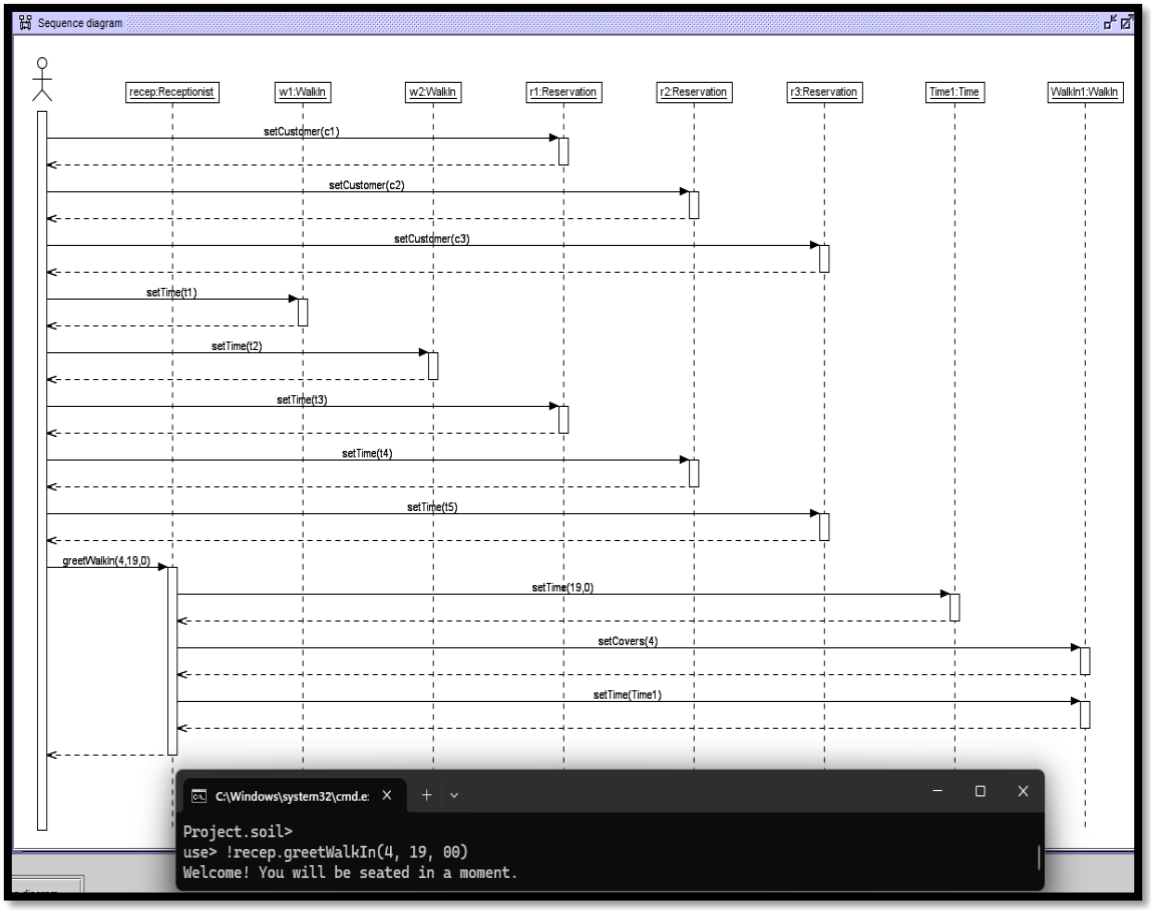


Part 2

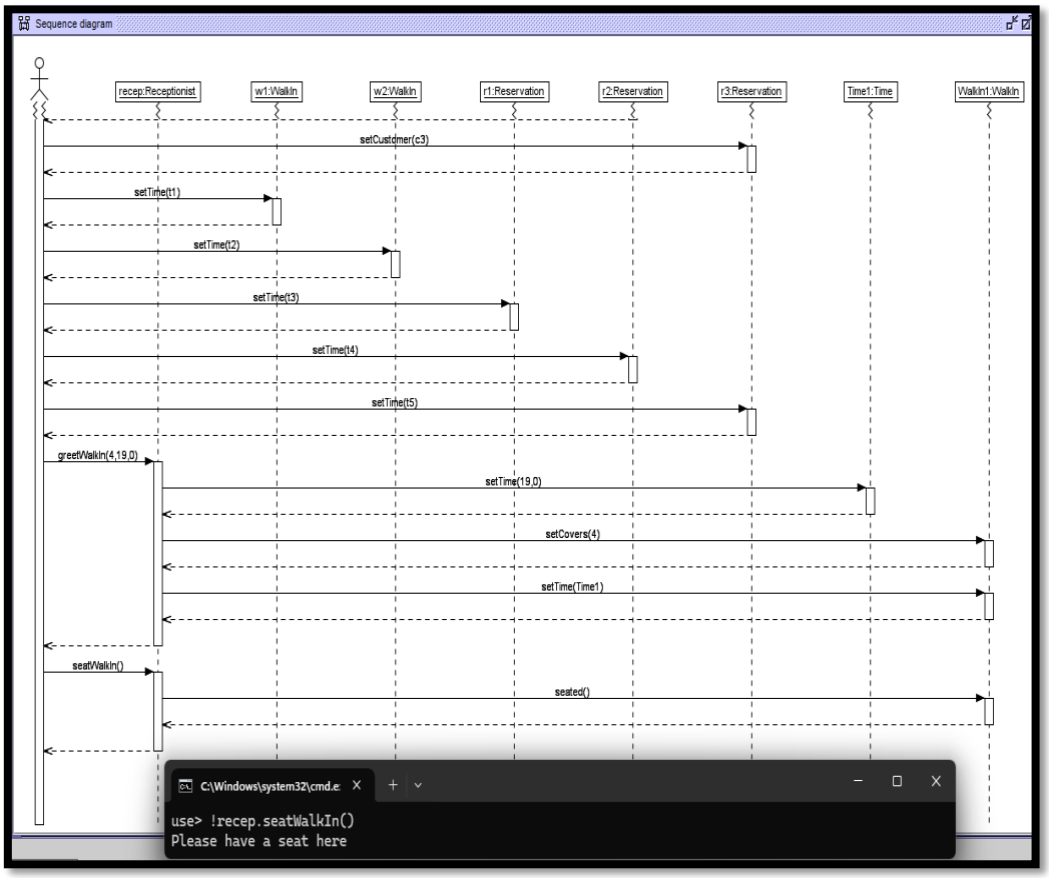

Object diagram
bookSys:BookingSystem
Uses
Uses
Uses
c1:Customer
name='Aniket Bedade'
age=17
phoneNumber='C22448826'
c2:Customer
name='Aaron Baggot!'
age=48
phoneNumber='C22716399'
c3:Customer
name='John Smith'
age=25
phoneNumber='086 123 1234'
Makes
Makes
Makes
r1:Reservation
covers=4
time=t3
arrivalTime=null
t3:Time
hour=18
min=30
r2:Reservation
covers=2
time=t4
arrivalTime=null
t4:Time
hour=20
min=0
r3:Reservation
covers=2
time=t5
arrivalTime=null
t5:Time
hour=21
min=0
IsAt
IsAt
tb3:Table
tno=3
covers=2
tb2:Table
tno=2
covers=2
tb1:Table
tno=1
covers=4
tb4:Table
tno=4
covers=6
IsAt
IsAt
IsAt
w2:WalkIn
covers=4
time=t2
t2:Time
hour=18
min=0
w1:WalkIn
covers=3
time=t1
t1:Time
hour=20
min=30
WalkIn1:WalkIn
covers=4
time=Time1
Time1:Time
hour=19
min=0
Time2:Time
hour=19
min=0
recep:Receptionist
C:\Windows\system32\cmd.e:
Welcome! You will be seated in a moment.
use> !recep.seatWalkIn()
Im sorry, there are no tables available.
use> Im sorry, there are no tables available.

Receptionist Sequence Diagram

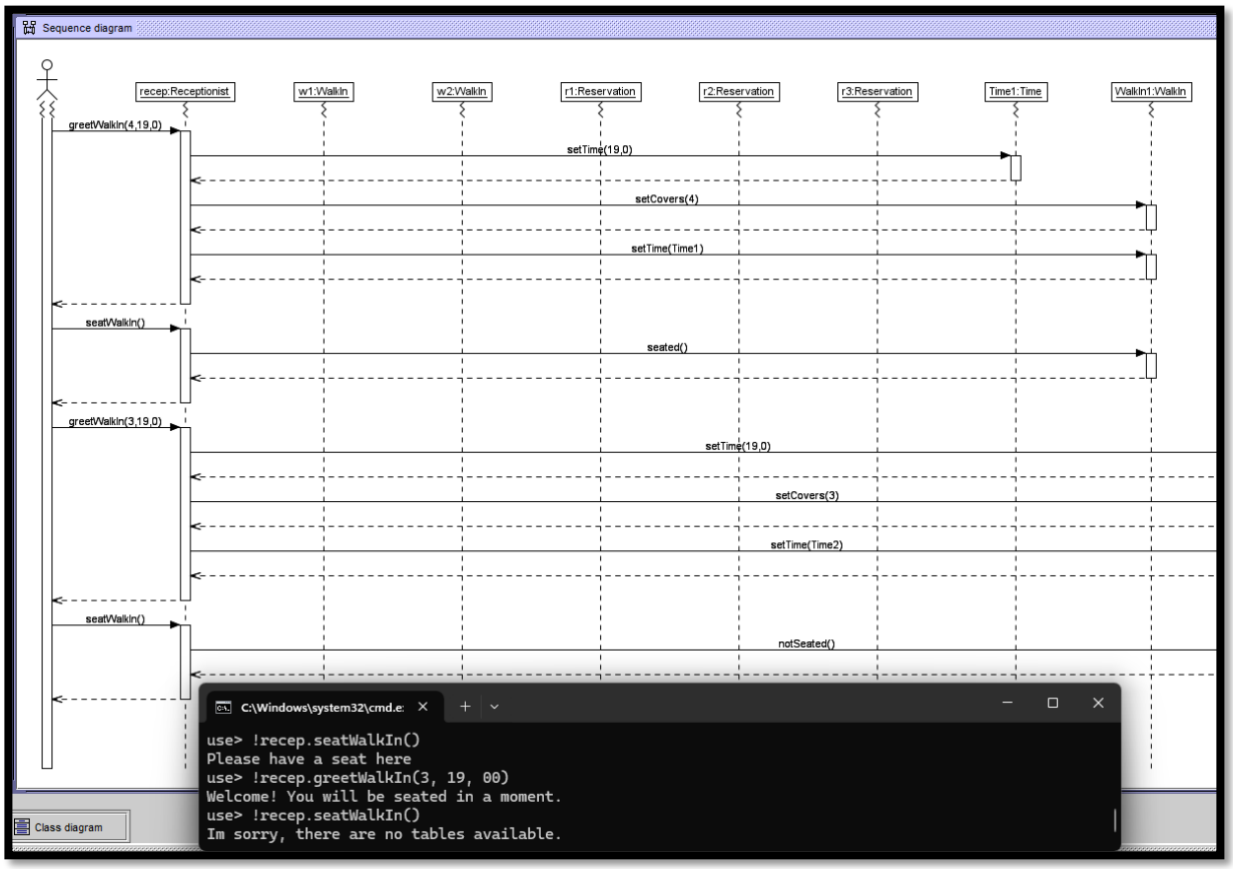
Greet WalkIn



Seat WalkIn


Sequence diagram
recep:Receptionist
w1:WalkIn
w2:WalkIn
r1:Reservation
r2:Reservation
r3:Reservation
Time1:Time
WalkIn1:WalkIn
setCustomer(c3)
setTime(t1)
setTime(t2)
setTime(t3)
setTime(t4)
setTime(t5)
greetWalkIn(4,19,0)
setTime(19,0)
setCovers(4)
setTime(Time1)
seatWalkIn()
seated()
C:\Windows\system32\cmd.e
use> !recep.seatWalkIn()
Please have a seat here

Seat WalkIn Fail



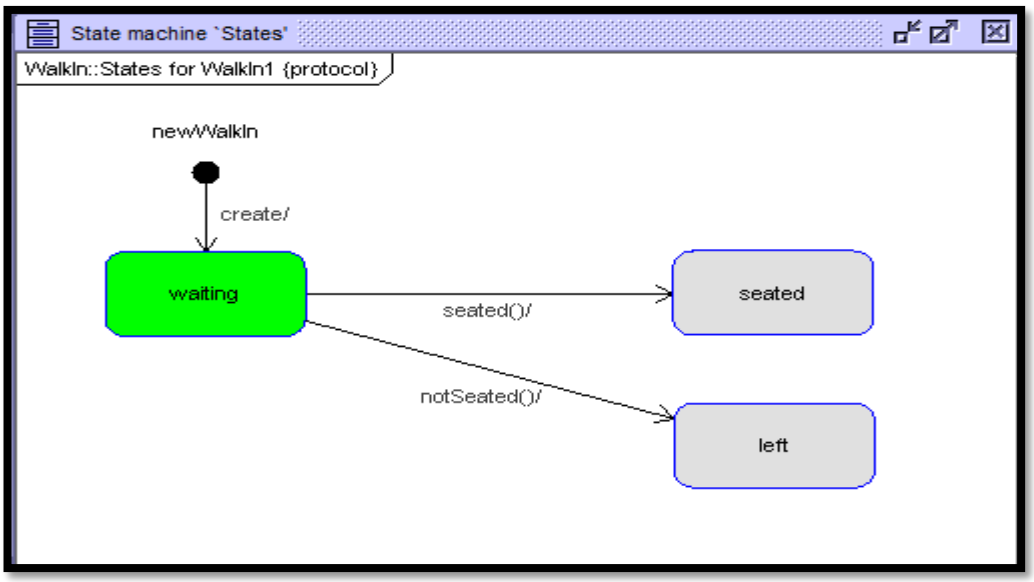
Walk In State Machine

When a walk-in arrives at the establishment, it enters a state machine that tracks its progression through various states based on the actions taken by the receptionist. Two key states within this state machine are “seated” and “not seated/left when none available”.

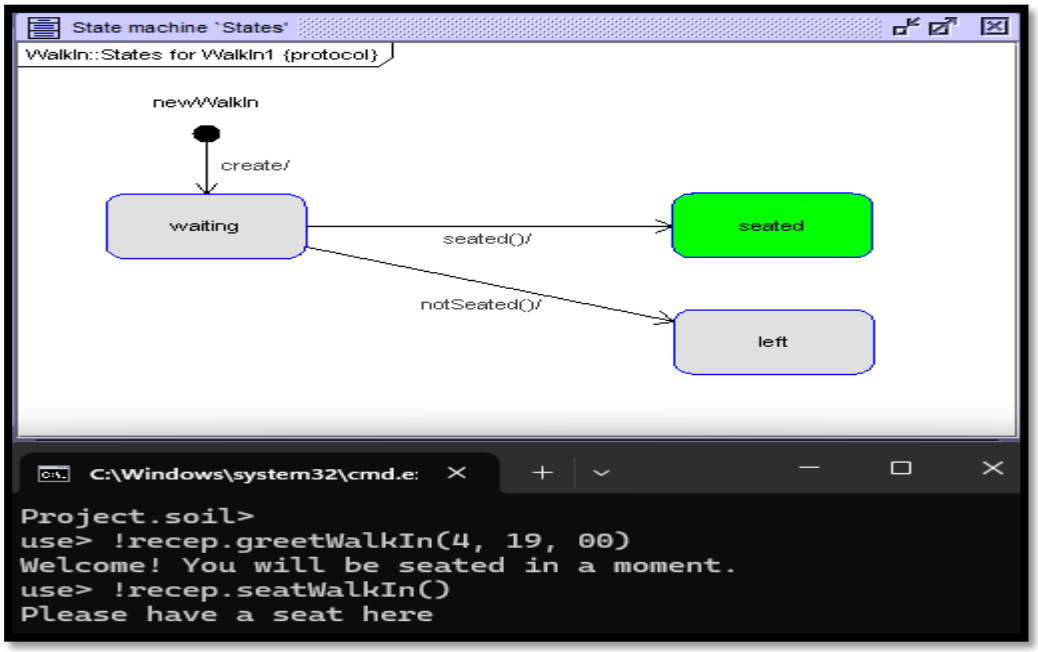
In the “seated” state, a walk-in has successfully been assigned to a table and is currently enjoying their dining experience. This state signifies that the walk-in has been accommodated and is actively engaged within the establishment.

Conversely, the “not seated/left when none available” state captures the scenario where no tables are available to accommodate the walk-in. In this state, the walk-in has not been seated and may choose to either wait for a table to become available or leave the establishment. This state reflects the system's acknowledgment of the walk-in's presence and its inability to immediately accommodate them due to resource constraints.

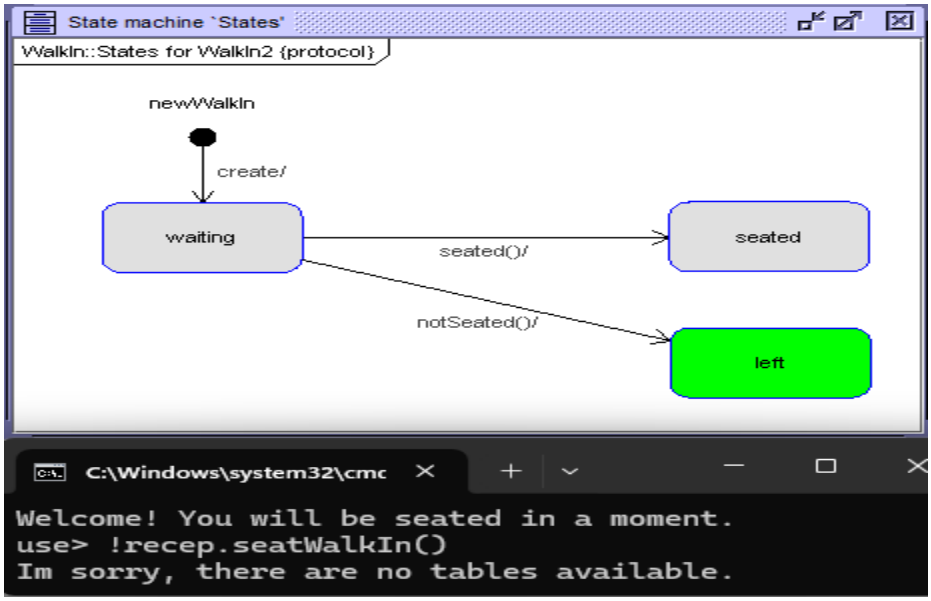
These state machines provide a structured approach to managing the flow of walk-in customers within the booking system, ensuring efficient handling of their requests and maintaining a positive customer experience even in cases where immediate seating is not feasible.



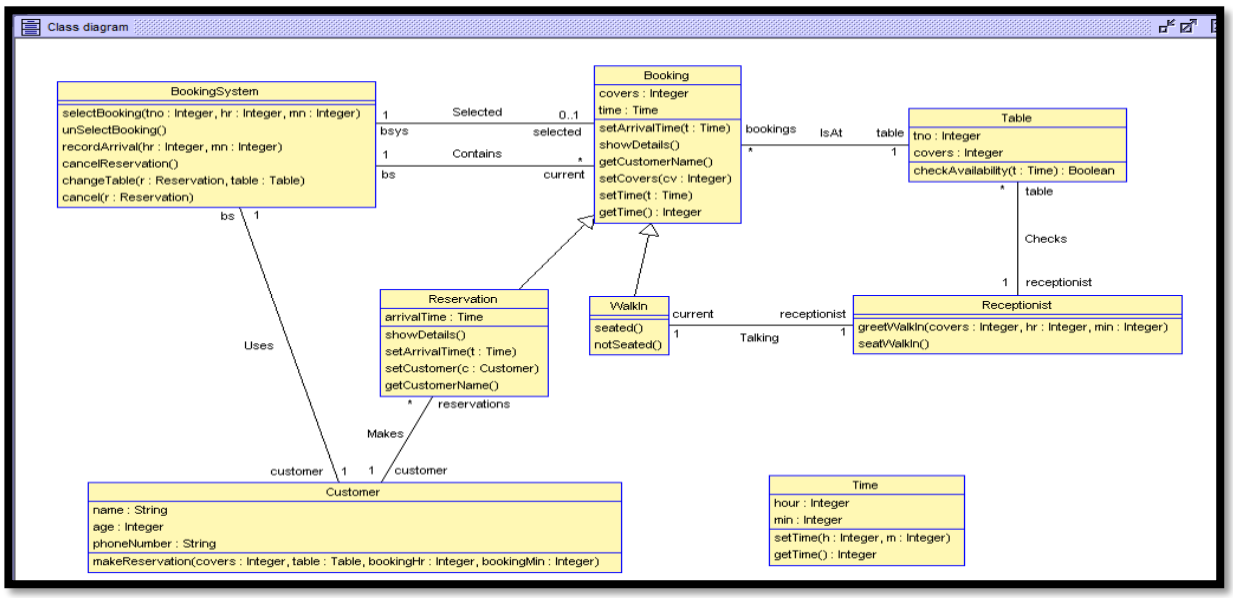
Seat WalkIn

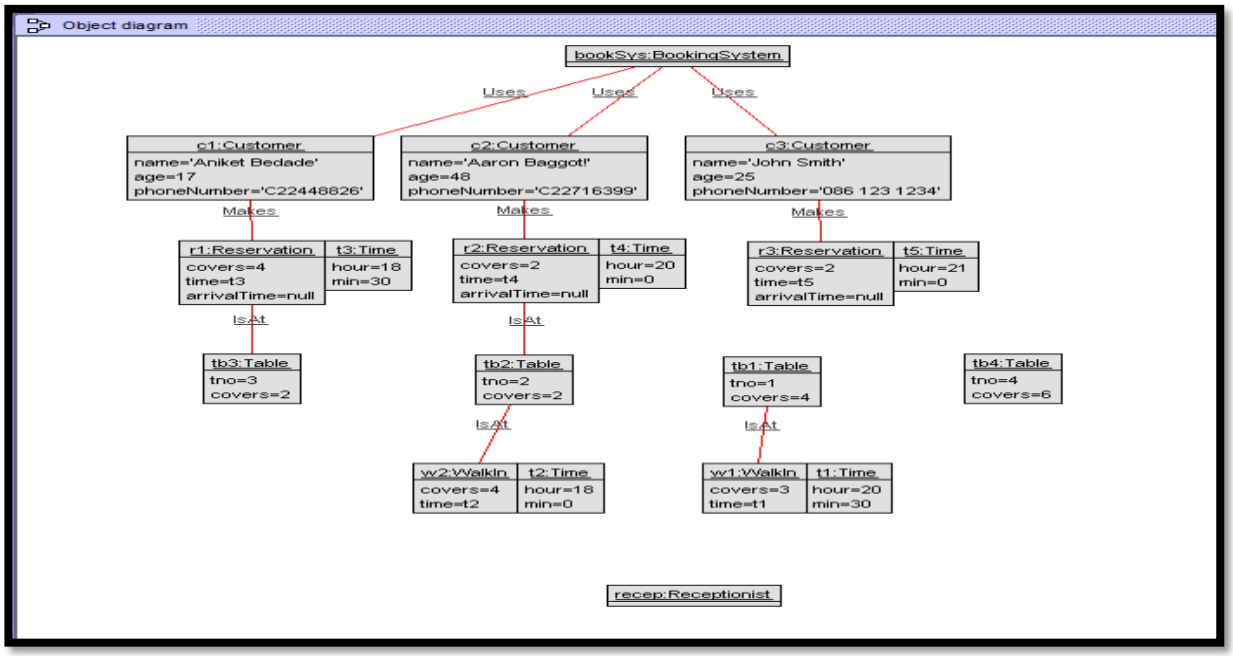


WalkIn Fail



Final Class and Object Diagrams

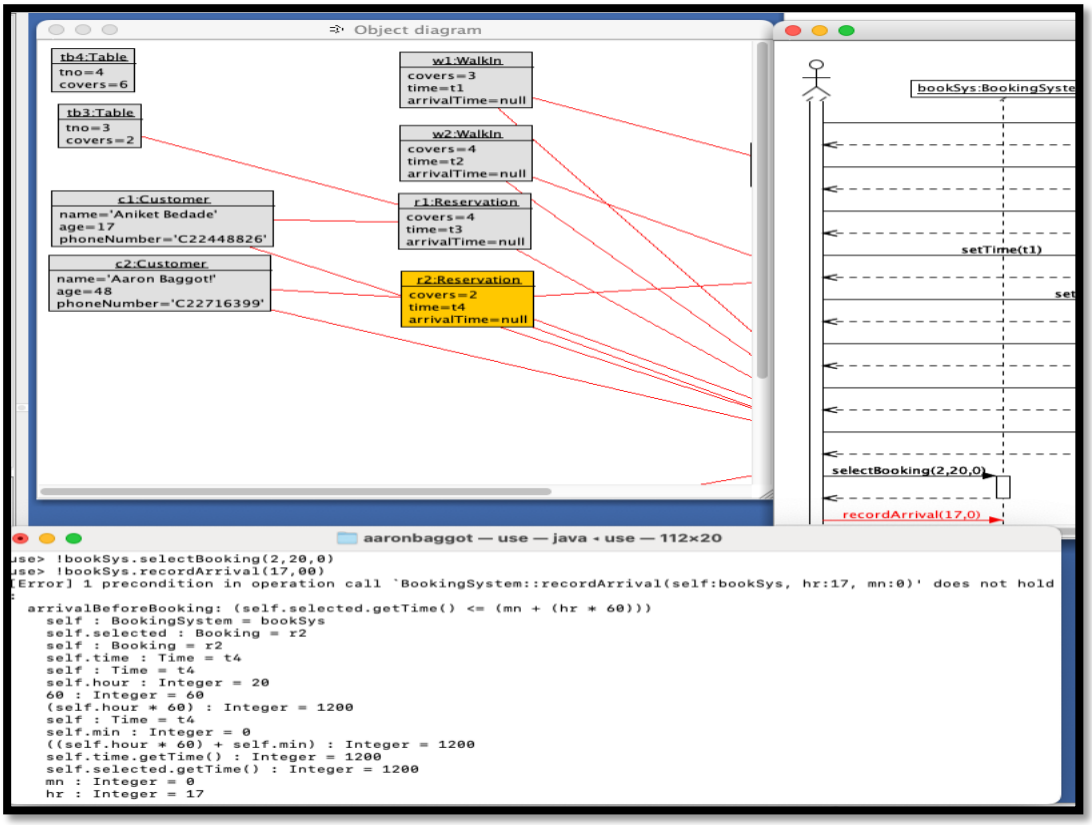




Pre and Post Conditions

Booking System Record Arrival

In the depicted sequence diagram, the interaction begins with a request to the booking system (bookSys) to select a booking for a table number 2 at 8:20 PM. This action is initiated by an external entity, denoted by the use> notation, indicating a request made by a user or another system component. Following this, the booking system attempts to process the request by calling the selectBooking() operation with the specified parameters. However, an error occurs during the subsequent step, where the booking system is unable to record the arrival of a customer at 5:00 PM (17:00) due to a precondition violation. The error message indicates that a precondition required for the recordArrival() operation is not met, preventing its successful execution. This sequence highlights the importance of ensuring that all preconditions are satisfied before invoking operations within the system to maintain its integrity and functionality.



Booking System Cancel Conditions

In the system's implementation, a state machine governs the cancellation of reservations, ensuring proper handling of booking cancellations. The cancellation process involves transitioning the reservation through different states to reflect its updated status within the system.

The cancel operation is subject to preconditions and postconditions to maintain consistency and integrity. The precondition, denoted as Pre1, asserts that the reservation to be cancelled (r) must currently exist within the system's list of current reservations (current). This ensures that only existing reservations can be cancelled, preventing erroneous or unauthorized cancellations.

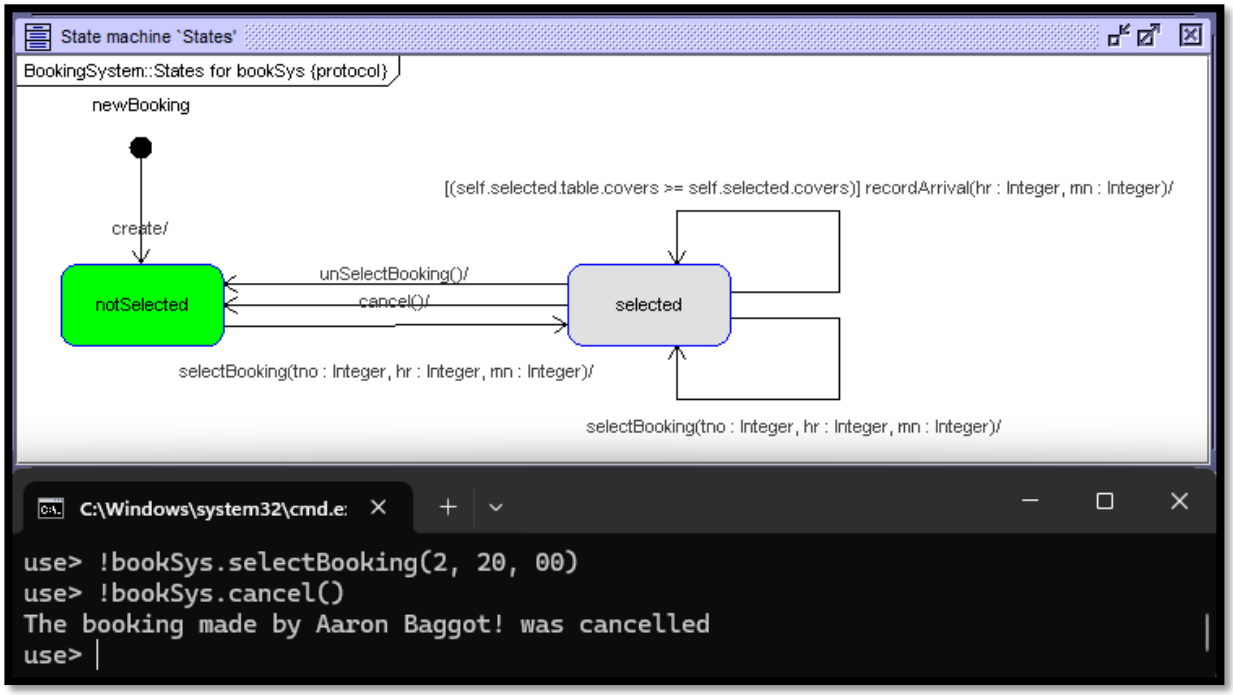
Following the cancellation operation, the system's state is modified according to the postcondition, labelled as Post1. This condition specifies that after the cancellation, the reservation r should no longer be included in the list of current reservations (current). This postcondition guarantees that the cancelled reservation is effectively removed from the system, preventing any further actions or interactions associated with it.

By enforcing these preconditions and postconditions, the system maintains consistency and reliability in managing reservation cancellations, ensuring that only valid cancellations are processed and that the system's state accurately reflects the outcome of the cancellation operation.

context BookingSystem::cancel(r : Reservation)

pre Pre1: current->includes(r)

post Post1: current->excludes(r)



Cancel Pre-Condition Success

```
use> !openter bookSys cancel(r1)
precondition `Pre1' is true
use> !opexit
postcondition `Post1' is false
  self : BookingSystem = bookSys
  self.current : Set(Booking) = Set{r1,r2,r3,w1,w2}
  r : Reservation = r1
  self.current->excludes(r) : Boolean = false
Error: postcondition false in operation call `BookingSystem::cancel(self:bookSys, r:r1)'.
```

```
use> !delete (bookSys, r2) from Contains
use> !openter bookSys cancel(r2)
precondition `Pre1' is false
Error: precondition false in operation call `BookingSystem::cancel(self:bookSys, r:r2)'.
use>
```

Cancel post success

```
use> !delete (bookSys, r1) from Contains
use> !opexit
postcondition `Post1' is true
```

Cancel pre success

```
use> !openter bookSys cancel(r1)
precondition `Pre1' is true
use> !opexit
postcondition `Post1' is false
  self : BookingSystem = bookSys
  self.current : Set(Booking) = Set{r1,r2,r3,w1,w2}
  r : Reservation = r1
  self.current->excludes(r) : Boolean = false
Error: postcondition false in operation call `BookingSystem::cancel(self:bookSys, r:r1)'.
```

Cancel pre fail

```
use> !delete (bookSys, r2) from Contains
use> !openter bookSys cancel(r2)
precondition `Pre1' is false
Error: precondition false in operation call `BookingSystem::cancel(self:bookSys, r:r2)'.
use>
```

Booking System Change Table

In the system's logic, the condition overNoOfCovers is a crucial aspect governing table changes within the booking system. This condition ensures that when a reservation requests a change in tables, the new table must have a sufficient capacity to accommodate the number of guests specified in the reservation.

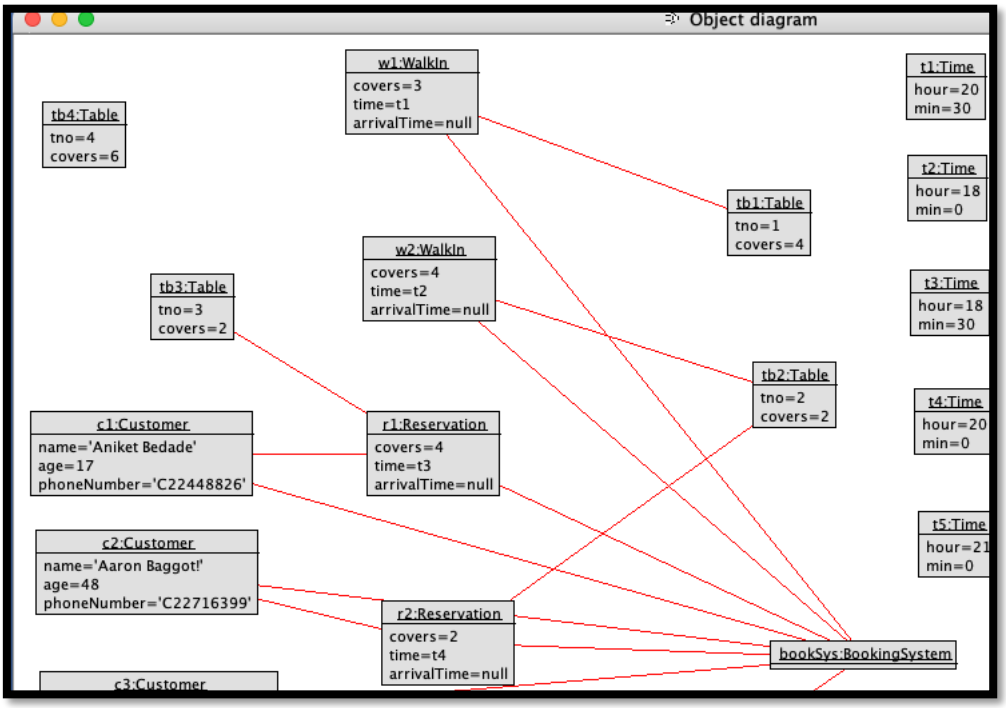
The scenario provided illustrates an attempt to change a reservation (r1) to a new table (th2). However, the operation fails due to the violation of the overNoOfCovers condition. The error message indicates that the requested table is not available, preventing the reservation from being moved to the new table. Subsequently, the system reports that the postcondition for the changeTable operation is false, indicating that the reservation's table does not include the new table after the attempted change.

overNoOfCovers()

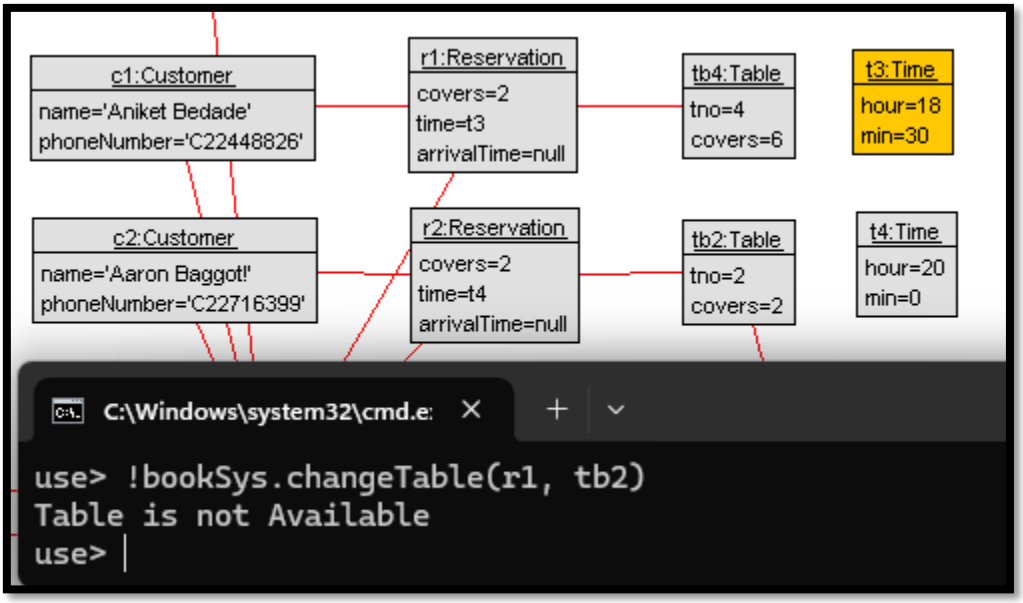
pre-condition

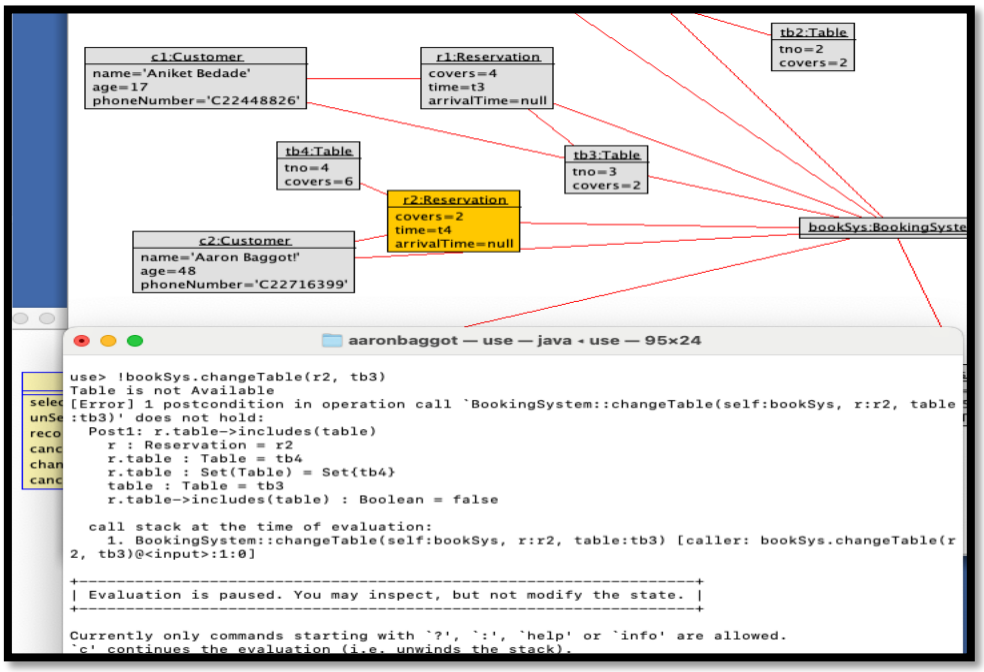
```
use> !bookSys.changeTable(r1, tb2)
[Error] 1 precondition in operation call `BookingSystem::changeTable(self:bookSys, r:r1, table:tb2)' does not hold:
  overNoOfCovers: (r.covers <= table.covers)
    r : Reservation = r1
    r.covers : Integer = 4
    table : Table = tb2
    table.covers : Integer = 2
    (r.covers <= table.covers) : Boolean = false

  call stack at the time of evaluation:
    1. BookingSystem::changeTable(self:bookSys, r:r1, table:tb2) [caller: bookSys.changeTable(r1, tb2)@<input>:1:0]

+-----------------------------------------------------------------+
| Evaluation is paused. You may inspect, but not modify the state. |
+-----------------------------------------------------------------+

Currently only commands starting with `?', `:', `help' or `info' are allowed.
`c' continues the evaluation (i.e. unwinds the stack).

Project.soil> Error: precondition false in operation call `BookingSystem::changeTable(self:bookSys, r:r1, table:tb2)'.
use>
```

Object diagram before implementation of conditions

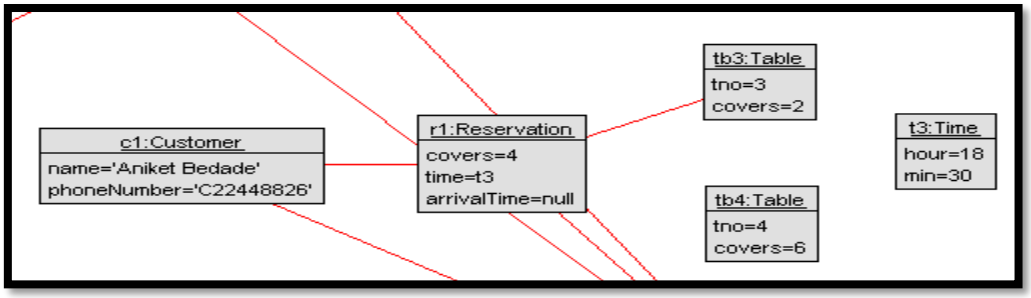


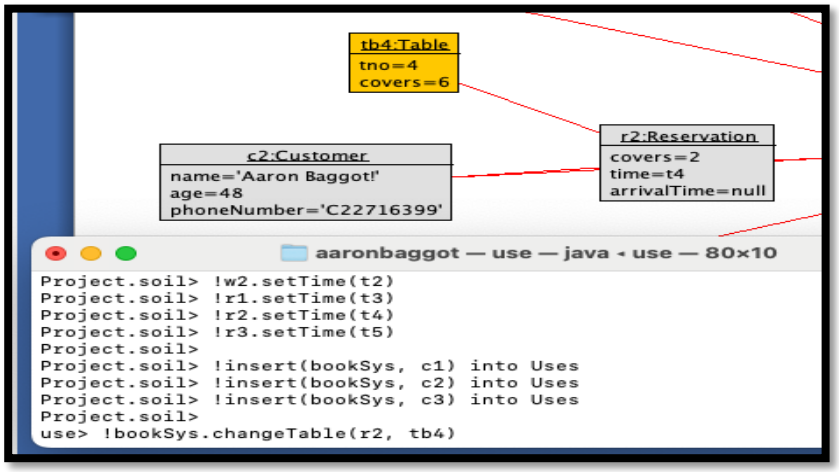
Post condition Fail – Table is not available



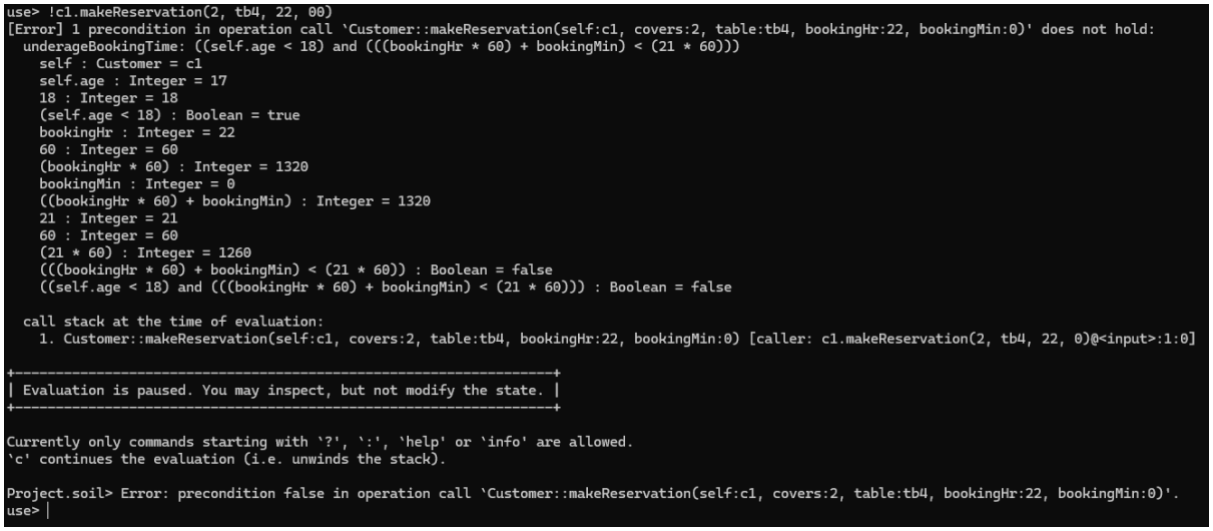


Post condition Success





Make Reservation – Underage Condition



Enhancement of Menu Ordering and Payment Systems

Although our efforts to implement enhancements to the restaurant management system were unsuccessful, we included a detailed report to demonstrate our commitment to introducing new features.

```
class Order
  attributes
    isPrepaid : Boolean init : false
    number : String
    price : Real init : 0

  operations
    addLineItem(quantity : Integer, p : Product)
    begin
        declare lineItem : OrderLine;
        lineItem := new OrderLine;
        insert(self,lineItem) into OrderContainsLine;

        -- centralized control here, not very OO in spirit

        lineItem.quantity := quantity;
        p.updateStock(quantity);
        insert (lineItem, p) into HasProduct
    end

    calculatePrice() : Real
    begin
        declare item:OrderLine, upr:Real, pr:Real, q:Integer, p:Product;

        self.price := 0;
        for item in self.lineItems do
            -- even more centralized control as in Fowler chap 4 example
            q := item.getQuantity();
            p := item.getProduct();
            upr := p.getUnitPrice();
            pr := self.calculateBasePrice(q, upr);

            self.price := self.price + pr
        end;
        result:= self.price
    end

    calculateBasePrice(q : Integer, unitPrice : Real) : Real
    begin
        if q >= 3 then
                result := q * unitPrice * 0.9   -- 10% off
            else
                result := q * unitPrice
        end
    end
end
```

```
class OrderLine
  attributes
    price : Real  init : 0
    quantity : Integer
  operations
    getQuantity() : Integer
    begin
        result := self.quantity
    end

    getProduct() : Product
    begin
        result := self.product
    end

end

class Product
  attributes
    name : String
    price : Real
    stockLevel : Integer init : 8

  operations
    getUnitPrice() : Real
    begin
        result := self.price
    end

    updateStock(q : Integer)
    begin
        self.stockLevel := self.stockLevel - q
    end
end
```

```
class OrderLine
  attributes
    price : Real  init : 0
    quantity : Integer
  operations
    getQuantity() : Integer
    begin
        result := self.quantity
    end

    getProduct() : Product
    begin
        result := self.product
    end

end

class Product
  attributes
    name : String
    price : Real
    stockLevel : Integer init : 8

  operations
    getUnitPrice() : Real
    begin
        result := self.price
    end

    updateStock(q : Integer)
    begin
        self.stockLevel := self.stockLevel - q
    end
end
```

Payment System Adaptation

Our goal here was to adapt the payment system to accommodate both card and cash transactions, providing customers with greater flexibility in settling their bills. The main objectives included.

Support for Multiple Payment Methods: Modifying the payment system to accept various payment methods, including credit/debit cards and cash.

Use Case Scenarios: Crafting scenarios to illustrate different payment processing scenarios, such as customers choosing between card and cash payments, processing contactless payments, and managing cash transactions.

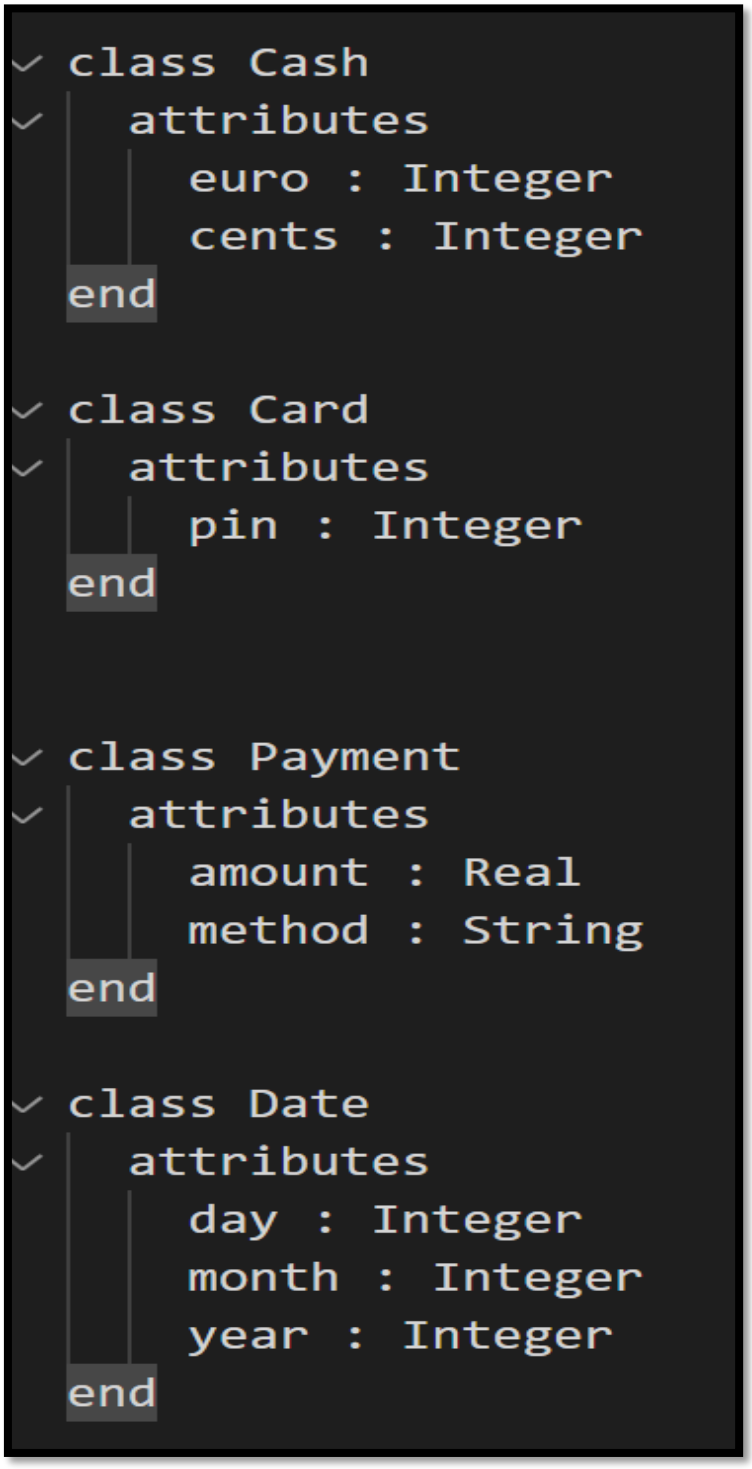
We also defined preconditions, postconditions, and invariants to ensure the security and accuracy of payment transactions, including verification of card authenticity and reconciliation of cash amounts.

Insights and Reflections:

Throughout the implementation process, we encountered challenges related to system complexity and impacts on cohesion and coupling. However, these challenges provided valuable insights into system architecture and design considerations. We learned the importance of balancing system flexibility with maintainability and the need for robust error handling mechanisms.

```
class PaymentSystem
  attributes
    cash : Cash
    card : Card

  operations
    selectPayment(booking: Booking, cashAmount: Integer, cardPin: Integer)
    begin
        if (cashAmount > 0) then
          self.cash.euro := cashAmount;
          self.cash.cents := 0;
          booking.payment := self.cash;
        end;

        if (cardPin > 999 and cardPin < 10000) then  -- Check if PIN is 4 digits
            self.card.pin := cardPin;
            booking.cardpayment := self.card;
            WriteLine('Payment processed successfully.');
        else
            WriteLine('Invalid PIN. Please enter a 4-digit PIN.');
        end;
    end
end
```

```
association PaysCash between
    Customer[1]
    Cash[*] role payment
end

association HasCard between
    Customer[1]
    Card[*] role cards
end



association PayCard between
    Customer[1]
    Card[*] role payment
end
```


class Cash
attributes
euro : Integer
cents : Integer
end
class Card
attributes
pin : Integer
end
class Payment
attributes
amount : Real
method : String
end
class Date
attributes
day : Integer
month : Integer
year : Integer
end

```
--Process payment operation
processPayment(booking: Booking, amount: Real, paymentMethod: String)
begin
    -- Create a new Payment object
    declare payment: Payment;
    payment := new Payment;
    payment.amount := amount;
    payment.method := paymentMethod;

    -- Associate the Payment with the Booking
    insert(booking, payment) into Pay;

    WriteLine('Payment processed successfully.');
end
```

Restaurant Project Code

The provided code constitutes a model for a booking system tailored to manage reservations and walk-in customers within an establishment. Developed by Aaron Baggot and Aniket Bedade, this model encapsulates various classes and operations aimed at orchestrating the booking process, handling reservations, and seating customers.

The main control class, BookingSystem, governs core operations crucial for managing bookings. These include selecting a booking, recording customer arrivals, cancelling reservations, and facilitating table changes. Additionally, the BookingSystem class integrates a state machine to guide the flow of operations, ensuring a systematic progression from booking selection to finalization or cancellation.

To complement the system's functionality, auxiliary classes such as Receptionist, WalkIn, Reservation, Customer, Table, and Time have been implemented. These classes facilitate interactions between system components, manage customer data, and provide essential functionalities such as checking table availability and setting booking times.

Furthermore, the model incorporates constraints and associations to enforce business rules and maintain data integrity. Constraints such as underage booking restrictions and table booking overlap prevention enhance the system's robustness and reliability.

Overall, this model serves as a foundational framework for developing a comprehensive booking management system, offering a structured approach to handle reservations, walk-ins, and table assignments within a hospitality setting.

```
-- Aniket Bedade C22448826
-- Aaron Baggot C22716399
model BookingSys

-- main control class

class BookingSystem

 operations
  selectBooking(tno : Integer, hr : Integer, mn : Integer)
  begin
   for r in self.current do
    if (r.table.tno = tno and r.getTime() = hr*60+mn) then
     insert(self,r) into Selected
    end
   end
  end

  unSelectBooking()
  begin
   delete (self,self.selected) from Selected
  end

  recordArrival(hr : Integer, mn : Integer)
  begin
   declare t: Time;
   t := new Time;
   t.setTime(hr, mn);
   self.selected.setArrivalTime(t);
   WriteLine('Customer has just been seated ');
   self.selected.showDetails()
  end

  cancelReservation()
  begin
   Write('The booking made by ');
   self.selected.getCustomerName();
   WriteLine(' was cancelled');
   destroy self.selected
  end

  changeTable(r : Reservation, table : Table)
  begin
   if (table.checkAvailability(r.time)) then
    delete (r, r.table) from IsAt;
    insert(r, table) into IsAt
```

```
    else
     WriteLine('Table is not Available')
    end
   end

   -- version of cancel not defined in SOIL
   cancel(r : Reservation)

  statemachines
   psm States
   states
    newBooking : initial
    notSelected
    selected
   transitions
    newBooking ->  notSelected  { create }
    notSelected -> selected { selectBooking() }
    selected -> selected { [self.selected.table.covers >= self.selected.covers]
recordArrival() }
    selected -> selected { selectBooking() }
    selected -> notSelected { unSelectBooking() }
    selected -> notSelected { cancelReservation() }
    notSelected -> notSelected { cancel() }
   end
  end


class Booking
  attributes
   covers : Integer
   time : Time

  operations
   setArrivalTime(t: Time)
   begin
   end

   showDetails()
   begin
   end

   getCustomerName()
   begin
   end

   setCovers(cv : Integer)
   begin
```

```
    self.covers := cv
  end

  setTime(t : Time)
  begin
    self.time := t
  end

  -- A query operation to retun the time of the booking in minutes
  getTime() : Integer = time.getTime()
end

class Receptionist
 operations
  greetWalkIn(covers : Integer, hr : Integer, min : Integer)
  begin
   declare w : WalkIn, t : Time;
   t := new Time;
   t.setTime(hr, min);

   w := new WalkIn;
   w.setCovers(covers);
   w.setTime(t);

   insert(self, w) into Talking;

   WriteLine('Welcome! You will be seated in a moment.')
  end

  seatWalkIn()
  begin
   declare run : Boolean;
   run := true;
   for tb in self.table do
    if (run and tb.checkAvailability(self.current.time) and self.current.covers <=
tb.covers) then
      insert(self.current, tb) into IsAt;
      self.current.seated();
      WriteLine('Please have a seat here');
      delete(self, self.current) from Talking;
      run := false
     end
   end;

   if (run) then
    WriteLine('Im sorry, there are no tables available.');
    self.current.notSeated();
```

```
      destroy self.current
    end
  end
end

class WalkIn < Booking

 -- dummy operations to change states in statemachine
 operations
 seated()
 begin
 end

 notSeated()
 begin
 end

 statemachines
 psm States
 states
  newWalkIn : initial
  waiting
  seated
  left
 transitions
  newWalkIn -> waiting { create }
  waiting -> seated { seated() }
  waiting -> left { notSeated() }
 end
end


class Reservation < Booking
 attributes
  arrivalTime : Time
 operations
  showDetails()
  begin
    Write('Selected reservation is by ');
    WriteLine(self.customer.name)
  end

  setArrivalTime(t : Time)
  begin
    self.arrivalTime := t
  end
```

```
  setCustomer(c : Customer)
  begin
    insert(c, self) into Makes
  end

  getCustomerName()
  begin
   Write(self.customer.name)
  end

        statemachines
                psm States
                states
                        newReservation : initial
                        waiting
                        seated
                transitions
                        newReservation -> waiting { create }
                        waiting -> seated { setArrivalTime() }
                end
end


class Customer
 attributes
  name : String
  age : Integer
  phoneNumber : String
 operations
  makeReservation(covers : Integer, table : Table, bookingHr : Integer, bookingMin :
Integer)
  begin
   declare time : Time, r : Reservation;
   time := new Time;
   time.setTime(bookingHr, bookingMin);

   if (table.checkAvailability(time)) then
    r := new Reservation;
    r.setCovers(covers);
    r.setTime(time);
    r.setCustomer(self);

    -- add the new reservation to the BookingSystem
    insert(self.bs, r) into Contains;
    insert(r, table) into IsAt;

    WriteLine('Reservation made successfully.')
```

```
    else
     -- delete the new Time object
     WriteLine('Table is not available.');
     destroy time
    end
  end
end


class Table
 attributes
  tno : Integer
  covers : Integer

 operations
  -- query operation to check if table is free
  checkAvailability(t : Time) : Boolean = self.bookings->size() = 0 or self.bookings-
>forAll(b | b.getTime() + 120 <= t.getTime() or t.getTime() + 120 <= b.getTime())
end


class Time
 attributes
  hour : Integer
  min : Integer
 operations
  setTime(h: Integer, m: Integer)
  begin
   self.hour := h;
   self.min := m
  end

  -- a query method to return the time since midnight in minutes
  getTime() : Integer = self.hour*60 + self.min
end

association IsAt between
  Booking[*] role bookings
  Table[1]
end

association Makes between
  Customer[1]
  Reservation[*] role reservations
end

association Talking between
```

```
   Receptionist[1]
   WalkIn[1] role current
end

association Checks between
  Receptionist[1]
  Table[*]
end

association Contains between
   BookingSystem[1] role bs
   Booking[*] role current
end

association Selected between
   BookingSystem[1] role bsys
   Booking[0..1] role selected
end

association Uses between
  BookingSystem[1] role bs
  Customer[1]
end


constraints

context BookingSystem::recordArrival(hr: Integer, mn: Integer)
   pre arrivalBeforeBooking: self.selected.getTime() <= mn + hr*60

context BookingSystem::cancel(r : Reservation)
   pre Pre1: current->includes(r)
   post Post1: current->excludes(r)

context BookingSystem::changeTable(r : Reservation, table : Table)
  pre overNoOfCovers: r.covers <= table.covers
  pre Pre1: r.table->excludes(table)
  post Post1: r.table->includes(table) or not table.checkAvailability(r.time)

context Customer::makeReservation(covers : Integer, table : Table, bookingHr :
Integer, bookingMin : Integer)
  pre underageBookingTime: self.age < 18 and bookingHr * 60 + bookingMin < 21 * 60

context Table
  inv noOverlap: self.bookings->forAll(b1, b2 | b1.getTime() + 120 <= b2.getTime() or
b2.getTime() + 120 <= b1.getTime())
```

```
context BookingSystem
  inv mustBeOneOf: not self.selected.isDefined() or self.current-
>includes(self.selected)
```

Conclusion

Embarking on the journey to extend and refine the restaurant management software has been an invaluable learning experience in the realm of software engineering. Through this project, I've gained hands-on experience in applying theoretical concepts to real-world scenarios, collaborating effectively with peers, and refining both technical and interpersonal skills. Each challenge encountered along the way served as an opportunity for growth, fostering a deeper understanding of the intricacies and potential of software engineering.

Reflecting on the project, I've come to appreciate the importance of proactive problem-solving and continuous improvement in software development. Our efforts to enhance the menu ordering and payment systems exemplify our dedication to delivering an exceptional dining experience for our customers. Moving forward, I'm eager to apply the knowledge and insights gained from this project to future endeavours, continually striving to innovate and elevate the quality of software solutions.

In conclusion, this project has not only deepened my understanding of software engineering principles but also instilled a sense of confidence and capability in tackling complex challenges.