New Restaurant Proposal

Jordan C. Reid
CS4632 Modeling and Simulation
Kennesaw State University
jreid71@students.kennesaw.edu
jreid.dev@gmail.com
https://github.com/jreiddev/Restaurant-Simulation-Model

I. Introduction

The goal for this model is to simulate a new restaurant and to answer what is the best way for the new restaurant to allocate its limited resources (employees, ingredients, seating for customers) so that cost remains low and customer satisfaction is guaranteed.

II. Project Overview

New Restaurant Proposal:

- Domain: A new real world restaurant with limited resources available.
- Problem Statement: What is the best way for newly established restaurant to manage limited resources so that profits remain as high as possible while simultaneously ensuring customer satisfaction
- Scope: This model will focus on customer satisfaction and resource management during the time a restaurant opens to a late afternoon shift, as this reflects one half of the day. The metrics gathered will help track inventory used, inventory cost, and customer patience and queue abandonment. This model will NOT be focusing on extended time frames, such as a week or month, employee satisfaction, employee wages, customer satisfaction with the meals taste, or random events such as customer celebrations, special menu options that draw in customers (i.e. Happy Hour, Ladies Night, etc), or competing restaurants.

III. System Description

- System Components and Dynamics:
  - Customers:
    - Project Focus: Arrival time, order, dining time, patience level for late orders
    - Behavior: Arrive at random times, wait in queue, place order, eat food, leave. (Customers also pay, but the server's tips will not be a part of this model)
  - Employees:
    - Project Focus: Position (cook, server), task speed, task complete, task completion error, shift duration.
    - Behavior: Can make mistakes slowing down speed of service, wasting ingredients, decreasing customer patience levels, increasing queue time.
    - Servers: Greet customers, take orders, get drinks, refill drinks, deliver food, check on customers, deliver check once customers finish eating, bus tables.
    - Cooks: Prepare ingredients, cook food, allocate time to larger/smaller orders
  - Interactions:
    - Customers form queues for limited servers/seats
    - Employee availability affects speed of operation/service time/customer wait time
    - Ingredient availability affects whether orders can be fulfilled, affecting customer patience levels.
    - Increase customer demand puts pressure on employees and inventory
    - Decrease customer demand causes servers to be slowly "cut" removing them from the day of operations
- Core Models and Algorithms:
  - Customer Queue and Service Time:
    - This model focuses on the time it takes for the customer to enter, be sat, order food, have food be delivered, eat, and leave.
    - Purpose: This will measure our modeled customers' wait times and determine the length of time they remain in the queue. This will also impact staffing levels, distributed work per employee, and customer satisfaction/patience.
  - Customer Patience and Abandonment:

    - This model focuses on the patience threshold that will determine whether or not a customer remains within the system/queue or decides to abandon model out of frustration.
    - As waiting time exceeds the determined average rate, patience level diminishes, and once it hits zero, the customer will decide to abandon the system.
    - Purpose: This model will reflect real world frustration felt by potential customers. The model creates a direct link between all service delays to lost profit, and will create a basis needed to evaluate the tradeoff between increasing staffing cost and increasing customer retention.
  - Discrete-Event Simulation
    - The model will operate as a discrete-event simulation, where state changes occur at specific events instead of having time flow at a constant rate.
    - Events:
      - Customer arrives
      - Customer sat at table
      - Customer decides on meal
      - Server takes the customers' order
      - Kitchen staff successfully complete the order
      - Server delivers food to the customer
      - Customer finishes eating
      - Customer pays and leaves
      - Employee shifts start/end
    - System State Variables:
      - Number of customers remaining in queue
      - Available servers and cooks
      - Ingredient inventory available
      - Average customer satisfaction score
      - Employee utilization rate
  - Inventory Consumption and Waste versus Inventory Cost
    - The ingredients used will be reflected in the model as consumed resources. This will tie each ingredient to all orders being completed.
      - Each order available to customers consumes a predetermined quantity of available ingredients
      - Employee errors lead to ingredients being wasted
      - Inventory shortages can delay or cancel orders, decreasing customer satisfaction levels

IV. Implementation Approach

- Programming Language: Java will be the chosen language for this project as it is widely used and ideal for potential android applications.
- Development Environment: IntelliJ IDEA and standard Java libraries will be utilized.
- Simulation Type: Discrete-event
- Data Collection Plan: The following metrics are what will be tracked with this project
  - Average customer speed of service
  - Average customer patience levels that fall as time exceeds expectations
  - Employee availability to customers in queue
  - Employee utilization rates
  - Ingredients and their cost to usage/waste

V. Literature Review

- Core Models and Algorithms
  - Source 1: "6 Restaurant Waitlist Metrics You Need to Track" [1]
    - The information provided shows the average time customers are willing to wait to be sat as well as a model for "wait list turnover" to represent the rate of parties being sat to parties still on the wait-list queue.
    - This information will be utilized in calculating customer patience levels and potential queue size. As customers wait beyond the expected "30 minutes" or less, patience levels will slowly plummet until they decide to abandon the system. The "Waitlist Turnover" rate will assist in employee utilization and speed of service metrics

    - What I will adapt for my project specifically is the varying ”acceptable wait time” that was surveyed for this report. Customers will have varying patience levels and that will be reflected in the initialized acceptable time the customer is willing to wait.
- Source 2: ”Ways to Reduce Restaurant Industry Food Waste Costs” [2]
    - From this article two things will be utilized. The statistic that ”4% to 10% of food” produced never reaching customers, and how roughly ”$100,000 from each $1 million” spent on food goes to waste.
    - With the above statistics will be adapted into the human error equation that will affect speed of service. They will also reflect the increase to ingredient cost and further decrease ingredient availability.
    - The human errors will increase that increase speed of service, and therefore decrease customer patience will range from the minimum 4% to the maximum 10% based on the size of the customer and food order queues compared to the number of available employees. This increase in error percentage will reflect on the ingredients/cost of ingredients.
- Source 3: ”Food Services and Drinking Places: NAICS 722” [3]
    - The BLS has up to date information on the employee percentages within a restaurant.
    - This project will utilize the number of ”Waiters and waitresses” and the number of ”Cooks, restaurant.”
    - The above will generate a ratio of necessary employees and their occupation. As customer queues increase the necessity for more employees will as well, and this ratio provides information on what type of employee to hire for the shift.
- Source 4: ”How Many Employees Does It Take to Run a Restaurant?” [4]
    - The model provided by Auguste Escoffier, School of Culinary Arts shows that each server will average at ”five or six tables” each, as well as a total of ”12-40 total employees” for each restaurant.
    - The information above will reflect employee availability and utilization rates, as well as providing a starting point for necessary employees to be hired.
    - As servers reach the limit of ”six tables” the chance of human error will also increase, and when looking at the data generated from the model, the total employee count provided will be apart of server to cook ratio.
- Source 5: ”Reducing Customer Wait Time at a Fast Food Restaurant on Campus” [5]
    - The model within the publication shows a bell-curve for customer arrival times and number of customers, starting from 9am to 5pm, which reflects one shift of a restaurant.
    - Each passing of the hour will have an influx of customers and will have customers leave the queue. The model provided will allow estimation of how many customers to expect per hour of the shift.
    - The total number of customers in the restaurant will be reduced from the provided model, as this reflects an college campus, however the ratio of customers per hour will be used to reflect queue times, employee utilization, etc throughout the day.

VI. Diagrams

See next page

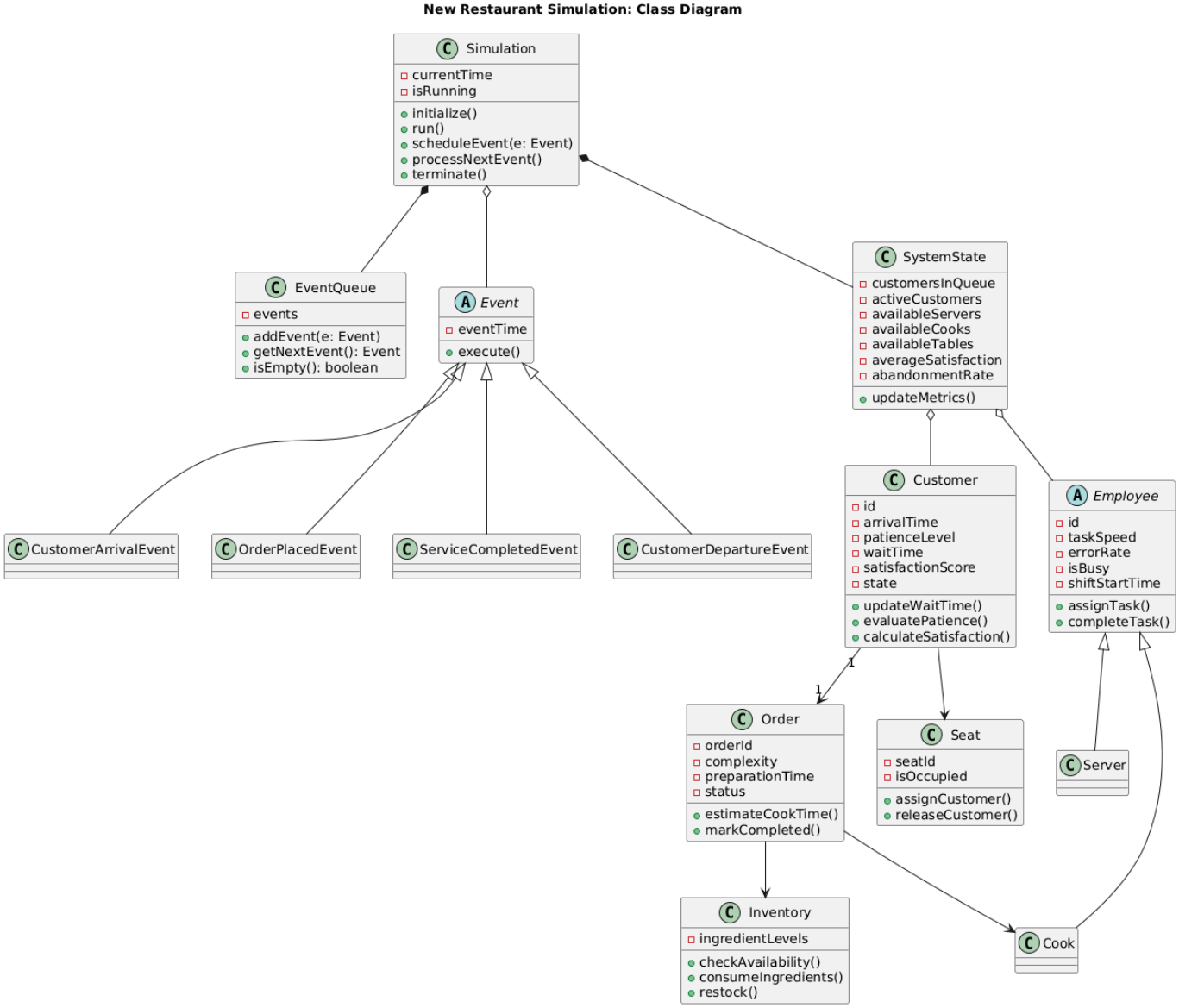

Fig. 1. Class Diagram UML

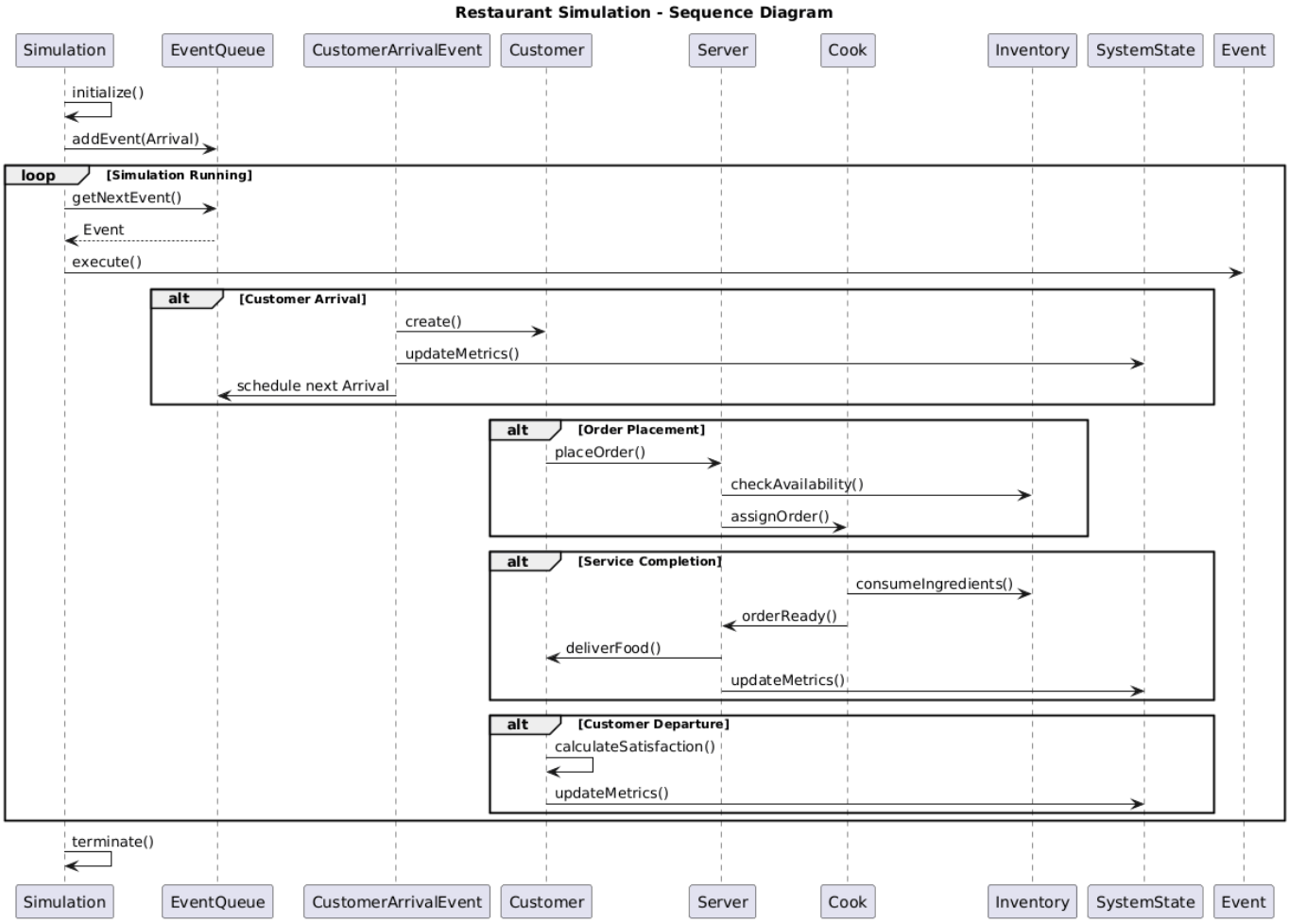

Fig. 2. Sequential Diagram UML

References

[1] T. Team, "6 Restaurant Waitlist Metrics You Need to Track — tablein.com," https://www.tablein.com/blog/restaurant-waitlist-metrics, 2023, [Accessed 03-02-2026].

[2] D. Blum, "Ways to reduce restaurant industry food waste costs," *International Journal of Applied Management and Technology*, vol. 19, no. 1, pp. 1–12, 2020.

[3] B. of Labor Statistics, "Food Services and Drinking Places: NAICS 722 : U.S. Bureau of Labor Statistics — bls.gov," https://www.bls.gov/iag/tgs/iag722.htm, 2026, [Accessed 03-02-2026].

[4] S. Larson, "How Many Employees Does It Take to Run a Restaurant? — escoffier.edu," https://www.escoffier.edu/blog/food-entrepreneurship/how-many-employees-does-it-take-to-run-a-restaurant/#:~:text={H}ere%20are%20some%20rough%20estimates%20for%20the,have%20roles%20that%20aren%27t%20needed%20in%20others., 2022, [Accessed 03-02-2026].

[5] Q. Iqbal, L. E. Whitman, and D. Malzahn, "Reducing customer wait time at a fast food restaurant on campus," *Journal of Foodservice Business Research*, vol. 15, no. 4, pp. 319–334, 2012.