Problem

Restaurants are perhaps one of the most difficult business to manage in a profitable manner, requiring a successful balance of revenue, customer satisfaction, and staff working conditions, while meeting many constraints. One task that embodies these challenges is seating customers. This complex task is dynamic in nature, as customer flow is neither fixed nor known, and many considerations such as efficient use of tables, minimal customer waiting time, even distribution of covers between servers, and kitchen work-load must be made. Seating of customers at a restaurant is an optimization problem. The objective is to maximize the revenue per available seat hour (RevPASH) without compromising customer or staff happiness. The problem is constrained by the number of tables, their potential configurations, available staff, and kitchen capacity.

I expect to find that a flexible seating algorithm that works in real-time will be more effective than a naïve first-come-first-serve (FCFS) seating scheme, in restaurant profit, customer satisfaction, and staff happiness.

Literature Review

My interest in the restaurant business stems from working in the industry during the summer. A cursory search for restaurant-related mathematical problems led to Jake Feldman's thesis on optimizing reservation scheduling. This paper considers a flexible model in which the establishment may either accept or reject a reservation request based on how it affects future potential seating arrangements.

The Feldman thesis referenced a PhD thesis at the National University of Ireland by Alfio Vidotto, regarding the use of constraint programming applied to restaurant table management. The lengthy dissertation considered the origin of uncertainty in customer flow, the programming and optimization challenges, and the dynamic nature of the problem. Vidotto also observed and tested his model in the real-world as part of his research. This paper demonstrated the success of constraint programming techniques in automating the seating process, which typically requires experienced personnel.

A study performed by Kimes, Barrash, and Alexander at the Cornell School of Hotel Administration took a more qualitative approach to managing restaurant revenue. In a case-study of one restaurant, the authors analyzed the restaurant's practices in order to maximize their profitability. The valuable concept of RevPASH was introduced as a quantity to maximize. They identified improved table management, which might be accomplished using automated optimization techniques, as a method to improve restaurant revenues.

Computation

A random process will be used to generate the set of reservations and walk-in customers. This process will simulate the customer flow for one night of restaurant operation. Data structures will be defined to represent the restaurant, its tables, and customers.

A simple dynamic seating algorithm will be defined and applied in real-time during the simulation. Integer programming will be used find the optimal configuration to maximize RevPASH for each time interval. Another, more naïve algorithm, will be defined to use FCFS to seat tables.

A Monte Carlo simulation will be performed for each seating strategy, and average performance data on revenue, customer count, and lost customers will be collected. The performance for the two strategies may then be compared, and conclusions made about which is preferable.

Impact and Expectations

The problem of seating restaurant tables is of interest to me primarily because of my experience with doing the complicated task manually. It is also of interest to restaurant managers due to its direct application to the field. The problem appeals to scientists and mathematicians because it is just one example of a scheduling problem, in which resources (tables) must be appropriately allocated in order to complete a task (serving customers). Methods used to solve the seating problem could be applied to other scheduling problems, such as others in the service industry, like hotel booking, or elsewhere, such as managing the power needs of the grid.

I expect the generation of a random process to model customers to take 1-2 days, design and implementation of a seating algorithm to require 2-3 days, the Monte Carlo simulation to take 1 day, and the data analysis and reporting of results to take 3-4 days. In total, I expect the project to be completed in a total of 10 days.

References

J. Feldman, *Optimizing Restaurant Reservation Scheduling,* Thesis, Harvey Mudd College, 2010.

A. Vidotto, *Managing Restaurant Tables Using Constraint Programming*, PhD Thesis, National University of Ireland, 2007.

S.E. Kimes, D.L. Barrash, J.E. Alexander, *Developing a Restaurant Revenue-Management Strategy*, Cornell Hotel and Restaurant Administration Quarterly, 40 (1999), pp. 18-29.