Jeans store management

Introduction

You are the owner of a fashion store specialized in jeans, and, given the customer arrival, you have to manage the inventory of jeans and the selling policy.

The decisions that you have to make are:

- The inventory of jeans, i.e. when to place an order of new jeans, and the associated number and size of jeans.
- The selling policy, i.e. the rules that you apply to sell jeans to customers if the appropriate size is not available.

The aim of the "Simulation Project" is to develop a discrete event simulation that represents the system and to evaluate the performance of two solutions of inventory and selling policy.

During the "Optimization Project", the discrete event simulation is expanded, and the optimal solution in term of inventory and selling policy is identified by an optimization algorithm.

Develop the discrete event simulation with a modular structure. It should be possible to modify the various components, such as the customer arrival rate, inventory and selling policy, during the "Optimization Project".

Project description

You plan the inventory for a season. A season lasts 100 days. You buy the jeans that you sell during the season from a producer. You can order jeans up to four times per season. The shipping for each order has a fixed cost of 150 € in addition to the cost of the purchased jeans. You sell back the unsold jeans to the same producer at the end of the season (day 100). You buy jeans from the producer for 50 € per pair of jeans, and you sell back the unsold jeans to the producer for 25 € per jeans. A pair of jeans has a storage cost of 0.10 € per day, considered from the day that the item arrives to the store until the day that the item is either sold or returned to the producer. You sell a pair of jeans to customers for 100 €. All jeans sizes have the same cost and price. You sell only one type of jeans in different sizes. The size of a pair of jeans is defined by the length size and the waist size. Available sizes for waist are S, M, L and XL. Available sizes for length are S, M and L. The store is open every day, and no jeans can be purchased after the end of the season.

Customers arrive at the store with a rate *c*. Customers are immediately served, and the service time can be considered zero. Customers request one pair of jeans of a specific length and waist size with a probability defined by *s*. If a jeans size is not available, a longer pair of jeans can be shortened. This applies only to the length, and not to the waist. A larger pair of jeans cannot be narrowed. Reducing the length of jeans costs 25 € to the store, and the selling price remains unchanged for the customers. Customers always buy jeans when they are available.

We assume the following distribution for the variables:

- The customer arrival rate *c* varies during the season:
  - *c* is equal to 75 customers per day from day 0 to day 33
  - *c* is equal to 45 customers per day from day 34 to day 66
  - *c* is equal to 60 customers per day from day 67 to day 100
- If a customer cannot be served with the available jeans inventory, the store incurs a lost sale, which impacts future demand by diverting customers to the competition. Each single lost sale leads to a 0.1% reduction of the current customer arrival rate *c*.
- The requested size probability *s* is uniformly distributed among the different sizes. We assume that, in a typical season, the same number of jeans of the different sizes is requested. There is no correlation between the required length and waist, and there are not sizes more requested than others.

Simulation

For the simulation project, you are requested to:

- Develop a discrete event simulation to represent the described project.
- Define the indexes used to quantify the success of the store.
  - Remember that extreme cases are important; evaluate other indexes in addition to the mean.
  - Report the mean square error of your estimation using bootstrapping when necessary.
  - Use variance reduction techniques to reduce the computational time.
- Decide the store policy regarding shortening longer jeans, i.e. the rules that you apply to sell jeans to customers if the appropriate size is not available. For example, you can decide which size of jeans to shorten, or even to not offer this service in some circumstances.
- Evaluate the success of the store with two different inventories and order strategy:
  - Two identical order of 3,500 jeans at day 0 and day 50. The jeans have sizes equally distributed
  - Three identical order of 2,000 jeans at day 0, day 33 and day 66. The jeans with sizes equally distributed, but you do not buy jeans with length S
- Make any necessary assumptions.

Optimization

For the optimization project, you are requested to:

- Identify the decision variables of the problem. You have the freedom to decide the order times and order quantities of each type of jeans, but you are limited to 4 orders in total per season.
- Define the objective function.
- Design an optimization algorithm and apply it to solve the problem. The value of the objective function is evaluated using simulation.
- Like in the simulation project, the objective function can reflect various policies of the decision maker: whether they want to optimize over the average, best, worst, or certain percentile of the objective function distribution. Decide what your position is and justify it, or present results for several alternatives.

- Use your creativity and explore service strategies, for example related to the shortening of long jeans.