IE4214: Revenue Management & Pricing Analytics Sem 1, 2023-2024

Final Project

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You can work on this project as a group of 2 to 4 students. The due day for submitting the project is 23:59, Sunday, 19 November, 2023. You need to sign up your group members through the google docs:

https://docs.google.com/document/d/1IYJFr7jr5SNz2Qmy01jeWgRaBmzTMJ6x_wZ93vYWG1E/edit?usp=sharing

Option 1: Choice Prediction and Assortment Optimization

Problem setup

We use an example in the computer microprocessor industry to illustrate the challenges of pricing and assortment optimization. Consider the three microprocessor stock-keeping-units (SKUs) are given in Table 1. Each SKU is defined as a unique combination of feature designs including the number of cores (number of processors run in parallel), frequency (speed of each core), TDP (an index of how much electric power the processor consumes), as well as price.

SKU	Cores	Frequency	TDP
a	4	3.2	95
b	8	2.9	60
c	8	2.9	95
d	4	2.9	60
e	4	3.2	60
f	4	2.2	135

Table 1: Example

For each SKU, there are 5 price levels: $[3000, 2700, 2400, 2100, 1800]$. Therefore, there are in total 6×5 products. We label products in the following way. Products 1 to 5 correspond to SKU a with price levels $3000, 2700, 2400, 2100, 1800$, respectively. Products 6 to 10 correspond to SKU b with price levels $3000, 2700, 2400, 2100, 1800$, respectively. The same goes for products 11 to 30. Product 0 denotes the outside option. The marginal costs for the products are set to zero due to the high production volume.

You are given a data set of market shares for 2500 assortments. Each assortment consists of 1 to 5 SKUs, each at a random price level. For each assortment, the market share (choice probability) of each product is given. These choice probabilities come from an unknown choice model. In "assortment.txt", you can find the compositions of these 600 assortments. In "probability.txt", you can find the choice probabilities of products in these assortments.

Here are your tasks.

(a) Predict the choice probability for products in each assortment in "assortment_test.txt". Write your prediction in "probability_test.txt". Make sure that the format is the same as that in "probability.txt". If your format is wrong, some points will be deducted. Please name your file as GroupXX.txt, where XX is your group number.

(b) Suppose the store decides to only carry the product b. What is the optimal price for this product? Note that you can set the price differently than the given price levels. For this question, you can submit three different solutions, and I would pick the one that has best performance. Hint: Assortments that contains only one product that you may want to pay particularly attention to. But you may also find choice probability of other assortments informative.

(c) Suppose the prices for SKU a,b,c,d,e,f are set to be $2400, 2100, 2700, 2100, 2100, 2700$, respectively. Now the store can carry at most 3 products. Determine the assortment of at most 3 SKUs to optimize the revenue. For this question only, you can submit three different solutions, and I would pick the one that has best performance.

We will calculate the revenues achieved by your pricing and/or assortment decisions based on a simulator. The following criteria will determine the final grade: the originality (whether you have innovation in your methods) and the revenue achieved by your solutions.

You need to write a report including your method (including reasons why use the method), analysis (if any), references (if any), and solutions. Submit your codes and reports. You can use any programming language, though Python is the recommended one.

Hints.

- These questions are not trivial, and not all the points are covered by lectures. Try to think deep into the problem and be creative.
- When deciding the choice model, you may want to balance the flexibility of the choice model and the computational complexity for corresponding decision problems.
- Because the problem size for this question is not large, the brutal force algorithms might be feasible. If you consider some approximation algorithms and obtain a good solution with much shorter time, you will gain some additional points.
- You would gain some bonus points if your method is innovative.
- A sample code on loading and saving the data file is provided.

Project 2: Self-Select Research Topics

For this option, you can choose a topic of your interest and conduct an extensive research on it. This option can be considered as an independent study module, but the expectations are higher as you will be working in a group and some technical preparation for the chosen topic is given in class. You can select from the following possible formats:

- Gather a dataset and perform an analysis on it;
- Conduct theoretical or numerical analysis on an extension of the topics covered in the class;
- Simulate a real-world system and identify/test some of its properties.

It is important that the chosen topic is related to the topics introduced in this course. Here are some topics that you can consider:

- Properties of network revenue management problem;
- Opaque mechanism design and pricing;
- Bundle pricing;
- Dataset that can demonstrate network effect.

Your task is to prepare a comprehensive report that covers all aspects of your project. The grade you receive will depend largely on the academic and/or practical value of your project. Please discuss the topic with me before you start working on your project, but I will not be able to provide in-depth consultation during the later stages. Once you have completed your project, please ensure that all files are zipped and submitted to Canvas.