Numerical Experiment

1 Compare Algorithm 2 with the modified Algorithm 2

In the modified Algorithm 2, the UCB term is updated by

$$\overline{D_t^k}(p) = \min\left\{\eta(p)^\top \hat{\theta}_t^k + \Delta_{tk}(p), \sum_{i=S_{k-1}}^{S_k-1} \underline{d}_i + (S_k - S_{k-1})L^2 \left\|\overline{p} - p\right\|_2\right\}, \tag{1}$$

where $\underline{d}_i$ is a lower bound of the demand in period i, $i \in [H]$. Or we simply use

$$\overline{D_t^k}(p) = \eta(p)^\top \hat{\theta}_t^k + \Delta_{tk}(p). \tag{2}$$

Experiment:

(a) Compare the modified Algorithm 2 using (1) with Explore-then-exploit algorithm.

(b) Try different values of lower bounds $\underline{d}_i$ and see how the average profit changes for the modified algorithm 2

(c) Compare the modified algorithm 2 using (2) with Explore-then-exploit algorithm

(d) Compare the two modified algorithm 2 with original Algorithm 2

2 Nonstationary demand functions over epochs

Currently, we assume that $D_{ti}(p) = a_i + b_i p$, $i \in [H]$, and b_i only dependent on the period i. We consider nonstationary demand $D_{ti}(p) = a_i + b_i(t)p$, $i \in [H]$. That is, the parameter of the price also depends on the epoch t. Define the total variation of sequence $b_i(t), t = 1, ..., T$ by

$$V = \sum_{t=2}^{T} |b_i(t+1) - b_i(t)|.$$

Experiment:

(a) Implement modified Algorithm 2 using (2) with

$$b_i(t) = -\left(5 + \sin\left(\frac{V\pi t}{2T}\right)\right), t = 1, ..., T$$

Try different value of $V = \log_2(T), T^{0.2}, T^{0.5}$.

Note: the total variation of the above sequence is approximately V.

3 Compare with Explore-then-exploit Heuristic

Compare algorithm 2 with Explore-then-exploit Heuristic. Use the same parameter setting as in Figure 2 of the paper. Also, plot a figure with a different parameter setting $H = 20, m = 5$.

Note: in the horizontal axis, the maximal of $\log_2(T)$ is 12.

4 More figures

(a) Plot a figure similar to Figure 2 in the paper, but with the vertical axis as the total regret $R_T^I(\pi_S)$, parameter settings are the same

(b) Plot a figure similar to Figure 2 in the paper, but with the vertical axis as the learning regret $\tilde{R}_T^I(\pi_S)$, parameter settings are the same

(c) Plot a figure similar to Figure 2 in the paper with the vertical axis as the average profit and average learning regret each. $H = 20, m = 5$

5 Phase Transition

This experiment aims to gain insights into Table 1 of the paper.

- Plot a figure to show the total regret $R_T^I(\pi_S)$, the x-axis is m, y-axis is the total regret. Consider both price allocations. Can we observe the big drop when m goes from $H-2$ to $H-1$? Maybe try $H = 5, 10, T = 2^8, 2^9, 2^{10}$

6 Compare uniform allocation and optimal allocation

(a) Consider $T = 128, H = 15$, compare learning regret of uniform allocation and optimal allocation. (Already done) Note that we observe some jumps when m is approaching

H, which may be because $\sqrt{H-m}+m$ has a relatively flat slope when $H-m$ is small (observed from the figure obtained) and the jump is from the order effect.