

Algorithms and Uncertainty

Winter Term 2025/26

Tutorial Session - Week 15

Exercise 1:

We are in the Bandits with Knapsacks setting.

- (a) Suppose we define the regret as

$$\text{Regret}^{(T)} := \max_{i=1,\dots,n} \sum_{t=1}^T r_i^{(t)} - \sum_{t=1}^T r_{I_t}^{(t)},$$

where I_t is the action we choose in step t . Why is this regret unreasonable?

- (b) Suppose we now compare ourselves to the best action $i \in N$ in hindsight, where $N := \{i = 1, \dots, n \mid \sum_{t=1}^T c_{i,j}^{(t)} \leq B \forall j\}$. What can we say about the regret in this case?

Exercise 2:

Consider a zero-sum game between Anton and Betty in which the following matrix shows Bettys winnings:

$$\begin{array}{c} B_1 \quad B_2 \quad B_3 \\ \begin{array}{l} A_1 \\ A_2 \\ A_3 \\ A_4 \end{array} \begin{pmatrix} -4 & 2 & 5 \\ 2 & -4 & -3 \\ 3 & -6 & -2 \\ -3 & 8 & 6 \end{pmatrix} \end{array}$$

- (a) Explain why Anton will never choose A_4 . Use this fact to reduce the game to one involving a 3×3 matrix.
- (b) Use similar thinking to reduce the game to one involving a 2×2 matrix.
- (c) Solve the 2×2 matrix game found in (b). Then use your answer to reveal the optimal strategies for Anton and Betty in the original 4×3 game.