

## PRICING AND BIDDING FOR RESOURCES USING THE KELLY MECHANISM

### APPLICATIONS OF RESEARCH AND INNOVATION – 2025/2026

INSTRUCTOR: CLEQUE-MARLAIN MBOULOU-MOUTOUBI  
AND FRANCESCO DE PELLEGRINI

Please read first the General Instructions and be sure you address the work breakdown described there.

**System to be simulated.** The paper(s) you are concerned with are to be found in the corresponding Moodle directory. You need to simulate a system where multiple agents bid for resources which are priced and assigned according to the Kelly mechanism. The Kelly mechanism description is found in [1][2][3][4]. You are *not* required to dig into the game theoretical aspects in depth, but rather to understand how the system works.

The game simulator should implement a system where players bid at a price decided by the resource provider by they are assigned a certain amount of resources according to the Kelly mechanism. Players arrive into the system according to a random process with intensity  $A$  arrivals per second and leave the system according to a random process with mean  $B$  departures per second. To start with, use exponential random variables for every such event.

**Note:** your implementation needs to be parametric: for instance, the number of players, the utility function of players, the arrival and the departure rate should be an input parameter. The utility function can be a generic concave function. The price function can be linear. Assume that players know what the others bid at the previous step (the resource owner will communicate the aggregated bid)

**Logical Components.** Whatever the implementation you will perform, I expect to see the following components.

**Component 1: Players.** Each player has a utility function and can bid for resources based on the aggregated bids communicated by the resource owner.

**Component 2: Resource owner.** The price owner fixes the resource prices and distributes the resources to the bidders.

**Component 3: Bidding mechanism.** Implements the Kelly mechanism.

**Component 4: Event handler.** This is the main engine of the event-driven simulator. The events that you need to simulate are the following.

- (1) Arrival and departures of players (it is a queue in fact);
- (2) Bidding action: players generate the events of bidding repeatedly based on their utility and the strategy of other players. You should implement different revision policies for the bidding: best response or gradient descent (have a look to [1] ). Ask your instructor for help on how to proceed.
- (3) Price adjustment: events when the price maker revise the price of the assigned resource. Start with static prices.

REFERENCES

- [1] C. M. Mboulou-Moutoubi, Y. B. Mazziane, F. De Pellegrini, and E. Altman, “Best-response learning in budgeted  $\alpha$ -fair kelly mechanisms,” in *NETGCOOP 2025-12th International Conference of Networks, Games, Control and Optimization*, 2025.
- [2] F. D. Pellegrini, A. Massaro, L. Goratti, and R. El-Azouzi, “Competitive caching of contents in 5g edge cloud networks,” 2016. [Online]. Available: <https://arxiv.org/abs/1612.01593>
- [3] M. Datar, E. Altman, F. De Pellegrini, R. El Azouzi, and C. Touati, “A mechanism for price differentiation and slicing in wireless networks,” in *2020 18th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOPT)*, 2020, pp. 1–8.
- [4] F. De Pellegrini, A. Massaro, L. Goratti, and R. El-Azouzi, “Bounded generalized kelly mechanism for multi-tenant caching in mobile edge clouds,” S. Lasaulce, T. Jimenez, and E. Solan, Eds., 2017.