

PRICING AND BIDDING FOR RESOURCES USING THE KELLY MECHANISM

APPLICATIONS OF RESEARCH AND INNOVATION – 2025/2026

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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 α -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.