Rokhlin D.B. (Southern Federal University, Rostov-on-Don, Russia). — **An analysis of some incentive mechanisms in multi-agent systems.**

We consider three different problems, concerning the resource management in multi-agent systems. In each problem the aim is to construct an incentive function, prompting the agents to follow strategies, which are optimal for the manager of the system.

In the first problem we consider the allocation of the network link capacities between large number N of users in order to maximize their aggregate utility. This is the network utility maximization (NUM) problem, introduced in [2]. In contrast to the usual hypothesis, we do not assume that the aggregate traffic, generated by the users over each link, is known. The proposed traffic pricing mechanism is based on the dual projected stochastic gradient descent method and utilize the following quantities: the total number N of users, the link capacities and the sequence of myopic optimal "reactions" of randomly selected users to the current prices. We show that for a special class of utility functions the errors in constraints and in the optimal network utility are bounded by $O(T^{-1/4})$ uniformly in N, where T is the number of reaction measurements. The proposed approach is compared theoretically and by the way of computer experiments to the fast gradient descent method of Nesterov, applied to the NUM problem in [1].

In the second problem (see [4]) we considers a manager, who allocates some fixed payment amount between N rational agents in order to maximize the aggregate production. The profit of i-th agent is the difference between the compensation, obtained from the manager, and the production cost. We compare (i) the normative compensation scheme, where the manager enforces the agents to follow an optimal cooperative strategy; (ii) the piece rates compensation scheme, where the manager announces a reward per unit good; (iii) the proportional compensation scheme, where agent's reward is proportional to his contribution to the total output. Denoting the correspondent total production levels by s^*, $\hat{s}$ and $\overline{s}$ respectively, where the last one is related to the unique Nash equilibrium, we examine the limits of the prices of anarchy $\mathscr{A}_N = s^*/\overline{s}$, $\mathscr{A}'_N = \hat{s}/\overline{s}$ as $N \to \infty$. We show, in particular, that for power costs (under some assumptions) asymptotically no performance is lost in terms of $\mathscr{A}'_N$, and in terms of $\mathscr{A}_N$ the loss does not exceed 31%.

Finally, in the third problem (motivated by [3]), we consider a Stackeberg game where manager's aim is to maximize the gain of a corporation by the distribution of funds between N producers. The manager selects a tuple of N incentive functions, and the producers play a discounted stochastic game, which results in a Nash equilibrium. Manager's aim is to maximize the corporation profit over a class of admissible incentive functions. It is shown that this problem is reduced to a Markov decision process.

REFERENCES

1. *Beck A., Nedić A., Ozdaglar A.* An $O(1/k)$ gradient method for network resource allocation problems, *IEEE Transactions on Control of Network Systems*, **1**:1 (2014), 64–73.
2. *Kelly F.P., Maulloo A.K., Tan D.K.H.* Rate control for communication networks: shadow prices, proportional fairness and stability, *Journal of the Operational Research Society*, **49**:3 (1998), 237–252.
3. *Novikov D.A., Shokhina, T.E.* Incentive mechanisms in dynamic active systems, *Automation and Remote Control*, **64**:12 (2003), 1912–1921.
4. *Rokhlin D.B., Usov A.* Asymptotic efficiency of the proportional compensation scheme for a large number of producers, *Yugoslav Journal of Operations Research*, **28**:4 (2018), 501–520.

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