Contest Manipulation for Improved Performance

Extended Abstract

Michal Habani, Priel Levy and David Sarne
Bar Ilan University, Israel
habani.mail@gmail.com,priel.levy@live.biu.ac.il,sarned@cs.biu.ac.il

ACM Reference Format:
Michal Habani, Priel Levy and David Sarne. 2019. Contest Manipulation for Improved Performance. In *Proc. of the 18th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2019), Montreal, Canada, May 13–17, 2019,* IFAAMAS, 3 pages.

1 INTRODUCTION

A contest is a situation in which participants compete with one another for prizes by expending some resources - time, effort or money. The contest mechanism can be used either to determine supremacy (e.g., in a sport, activity or particular quality) or in order to elicit effort and generate value (e.g., R&D competition, crowdsourcing contest (as TopCoder) or even a contest for soliciting transformative solutions for the benefit of humankind (as the Hult prize)). As such, much research has been carried out in recent years studying contest-based mechanism design [4–7, 15, 19, 27, 33].

In this short paper we outline our research focusing on a wide spectrum of contests where contestants do not strategize over the quality of their performance, which is a priori set, but rather only decide whether or not to participate in the contest, where participation is costly [8, 12, 16, 20, 30]. This contest model (which is often termed "simple contest" or "binary contest") applies to various real-life settings. The research adopts the simple contest model introduced in the seminal work of Ghosh and Kleinberg [2016] and suggests three manipulations (termed "enhancers" onwards) the contest organizer may take advantage of in order to maximize its expected profit from the contest. The first is changing the nature of the contest from a parallel one to a sequential one, introducing an order of participation and publicly disclosing the performance obtained by contestants as the contest progresses. Here, we show that despite giving away information that can improve the individual profits of contestants, possibly at the expense of the contest organizer, there are settings where the transition to a sequential contest offers much value also to the contest organizer. The second enhancer is based on adding some ambiguity to the way contestants' performance is determined, such that at the time of making their participation decisions the quality of one's individual contribution if participating is highly uncertain. This might seem highly counter-intuitive as it may push contestants that are likely to highly perform to opt not to participate in the first place. Still, we manage to demonstrate that there are settings where it is more beneficial for the organizer to have the contestants become somehow uncertain regarding their performance in the contest. Finally, we suggest the artificial increase in contestants' participation cost as a means for increasing the organizer's profit. This again, is highly counter-intuitive as it may hinder participation. Here, the improvement results from an effective tradeoff between the loss due to the decreased participation and the saving in the expected prize awarded. We note that the proposed enhancers are simple, yet novel in the sense that they have not been proposed before in the context of contest design. A simple solution is often the preferred one, as it is easier to implement and more likely to be adopted.

In the following section we formally introduce the contest underlying model used. Section 3 introduces the principle of an equilibrium analysis of the Ghosh and Kleinberg contest model. Related work is surveyed in section 4, and finally we conclude with a discussion. All in all, the use of the enhancers can be of great value to contest organizers and regulators aiming to influence markets' behavior and measures such as social and individual welfare.

2 THE MODEL

We adopt the simple contest model introduced by Ghosh and Kleinberg [2016]. The model considers a contest organizer and a set $A = \{A_1, ..., A_k\}$ of k heterogeneous contestants (denoted "agents" onwards). We use "quality" to relate to the performance of an agent if taking part in the contest. An agent's type is thus captured by its quality q, where types are drawn from a probability distribution function $f(q)$ (with $F(q)$ being the corresponding cumulative distribution function). The benefit of the contest organizer from the contest is either the expected maximum quality or the sum of qualities elicited in a contest. Participating in the contest is costly in a sense that the agent incurs a common cost c, therefore the choice of participation is not trivial. The contest is executed in parallel—all agents make their participation decisions simultaneously, having no information related to the quality of others.

In order to encourage participation, the organizer offers a prize $M \geq c$ to the agent ranked first (quality-wise) in the contest. If having two or more agents ranked-first, a tie-breaking rule is required. In case none of the agents chooses to participate, no prize is awarded, and the quality as perceived by the organizer is set to some predefined fallback quality q_0 (typically this will be zero). It is assumed that $f(q)$, c and M are common knowledge to all agents and the organizer. Also, prior to making its participation decision, each agent already knows (or becomes acquainted with) its own contribution quality (yet it is still unaware of the qualities of others).

The agents are fully rational and self interested, i.e., aiming to maximize their expected profit, defined as the expected prize they are awarded minus the cost c if participating and otherwise zero. The goal of the contest organizer is to maximize its expected profit defined as either the expected best quality or the expected sum of qualities of agents participating in the contest minus the prize awarded.

Proc. of the 18th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2019), N. Agmon, M. E. Taylor, E. Elkind, M. Veloso (eds.), May 13–17, 2019, Montreal, Canada.

3 ANALYSIS

Given the strategies (in the form of participation decisions) of the other agents, the best response strategy of each agent A_i is to participate iff its quality q_i is greater than some threshold r_i and otherwise not participate. The intuition for the proof is simple: in case A_i should participate given quality q_i, then its profit from participating is even greater for any $q > q_i$. Similarly, if according to the optimal strategy A_i should opt to avoid participating, then the same should hold for any $q < q_i$. While multi-equilibria is possible, we consider the symmetric equilibrium (that always holds) where each agent uses the same threshold r, as this is the most natural and fair solution.

3.1 Modified Sequential Contest

In a sequential contest, only one agent performs at a time and its performance quality becomes known to the following agents, and can be used for their decision making. In such a contest, agents have complete information regarding performance of those who participated before them in the sequence, hence the sub-game perfect Nash Equilibrium is fully in pure strategies. An agent's strategy is thus its choice of participation given the maximum quality obtained so far.

3.2 Ambiguous Measures of Performance

Adding some ambiguity to agents' knowledge regarding their performance quality in the contest is equivalent to not publishing to contestants the complete set of criteria for evaluating one's quality in the contest (or at least adding some ambiguity to the description). For simplicity we assume that the organizer does not provide any means for quality pre-evaluation, i.e., at the time of making its participation decision an agent can rely only on the a priori distribution of qualities $f(q)$.

3.3 Increase Participation Cost

Artificial participation costs can take the form of requesting contestants to fill in additional forms, asking them to supply some additional unneeded qualifying documents and so on. We emphasize that the proceeds from these additional costs are assumed to be wasted, i.e., the organizer does not directly benefit from them. Traditionally, an artificial increase in cost (which eventually is wasted and does not directly benefit any of the contestants) is regarded as a market inefficiency, and, as such, something to be avoided or reduced to a minimum.

4 RELATED WORK

Literature on contest design deals with two types of contests: effort-based and simple/binary contests. In the former, contestants can influence their winning chance by the amount of effort (or money) they exert [5, 6, 10, 17, 23, 34]. In recent years there is a growing interest in the study of a binary contest where contestants strategize on participation itself rather than the amount of effort to exert. Works on such simple contests have dealt primarily with information design [8, 16, 30], optimal prize allocation [11, 12, 32] and computational aspects of equilibrium-calculation [21].

The current paper suggests the benefit in using three enhancers to simple contest design. The first is the transition to sequential contest. While most prior work on contest design considered parallel contests [13, 26, 27], some examples for the use of sequential contests can be found primarily within the context of Tullock contests [1, 14, 25, 28]. These works differ from ours in the sense that their model assumes effort-based contests hence the equilibrium analysis is very different. Also, the analysis given in these works is limited to two or three agents. We have recently studied a sequential model [22], however that model assumes agents do not know their contribution quality ahead of time, hence the analysis does not fit our standard model.

The second enhancer suggests adding some ambiguity to the way contestants' performance is evaluated. In general, selective information disclosure has been extensively studied in the field of psychology and behavioral economics [35] and in multi-agent literature [29]. Specifically, in the area of contest design, models that incorporate uncertainty have been studied in the context of the information contestants know about others' abilities [2, 18, 36, 37]. These works do not attempt to compare performance under different levels of uncertainty. Our enhancer deals with a different type of uncertainty (related to contestants' knowledge of their own types, resulting in a very different equilibrium analysis) and studies the influence of an increase in such uncertainty over performance.

Finally, we study the effect of an increase in participation cost over performance. To the best of our knowledge, this issue has not been addressed in contests literature. Still, the idea of improving performance of multi-agent systems through the increase in costs agents incur (or by introducing "inefficiencies") under certain circumstances, is not new. For example, Sarne and Aumman [2014] show that an increase in search costs can improve overall performance in distributed two-sided search settings. Masters [1999] shows that an increase in minimum wage can have positive employment effects. Endriss et al. [2011] show that taxes can facilitate more desirable equilibria in Boolean games and Anshelevich et al. [2013] show a similar influence in centralized matching schemes.

5 DISCUSSION AND CONCLUSIONS

The paper suggests three enhancers that can potentially improve the expected profit of organizers of simple contests supporting both the case of maximizing the expected best quality and the sum of qualities obtained in the contest. All three enhancements introduced are easy to implement and do not require a substantial change in the contest mechanism. Furthermore, all three are somehow counter-intuitive and current real-life contests quite rarely make use of them: sequential contests are in use however mostly because it is infeasible to use a parallel contest (e.g., in Olympic sports such as platform diving, pole vault and javelin throw), evaluation criteria are typically published in full, enabling contestants as much information as possible, and participation costs are considered as market inefficiency and the general understanding is that these should be minimized. Hence the importance in demonstrating that they can be beneficial and their formal analysis.

ACKNOWLEDGMENTS

This research was partially supported by the ISRAEL SCIENCE FOUNDATION grant No. 1162/17.

REFERENCES

[1] J. Atsu Amegashie. 2000. Some results on rent-seeking contests with shortlisting. *Public Choice* 105, 3-4 (2000), 245–253.
[2] J. Atsu Amegashie et al. 2006. Information transmission in elimination contests. *Working Paper, Department of Economics, University of Guelph, Ontario* (2006).
[3] Elliot Anshelevich, Sanmay Das, and Yonatan Naamad. 2013. Anarchy, stability, and utopia: Creating better matchings. *Autonomous Agents and Multi-Agent Systems* 26, 1 (2013), 120–140.
[4] Nikoly Archak and Arun Sundararajan. 2009. Optimal design of crowdsourcing contests. *ICIS 2009 proceedings* (2009), 200.
[5] Ruggiero Cavallo and Shaili Jain. 2013. Winner-Take-All Crowdsourcing Contests with Stochastic Production. In *Proc. of HCOMP*. 34–41.
[6] Ani Dasgupta and Kofi O. Nti. 1998. Designing an optimal contest. *European Journal of Political Economy* 14, 4 (1998), 587 – 603.
[7] Emmanuel Dechenaux, Dan Kovenock, and Roman Sheremeta. 2015. A survey of experimental research on contests, all-pay auctions and tournaments. *Experimental Economics* 18, 4 (2015), 609–669.
[8] Pradeep Dubey. 2013. The role of information in contests. *Economics Letters* 120, 2 (2013), 160–163.
[9] Ulle Endriss, Sarit Kraus, Jerome Lang, and Michael Wooldridge. 2011. Designing Incentives for Boolean Games. In *Proc. of AAMAS*. 79–86.
[10] Qiang Fu and Jingfeng Lu. 2012. The optimal multi-stage contest. *Journal of Economic Theory* 51, 2 (2012), 351–382.
[11] Arpita Ghosh and Patrick Hummel. 2012. Implementing Optimal Outcomes in Social Computing: A Game-theoretic Approach. In *Proc. of WWW*. 539–548.
[12] Arpita Ghosh and Robert Kleinberg. 2016. Optimal Contest Design for Simple Agents. *ACM Transactions on Economic and Computation* 4, 4, Article 22 (2016), 22:1-22:41 pages.
[13] Amihai Glazer and Refael Hassin. 1988. Optimal Contests. *Economic Inquiry* 26, 1 (1988), 133–143.
[14] Amihai Glazer and Refael Hassin. 2000. Sequential rent seeking. *Public Choice* 102, 3-4 (2000), 219–228.
[15] Mark Gradstein and Kai A Konrad. 1999. Orchestrating Rent Seeking Contests. *Economic Journal* 109, 458 (1999), 536–545.
[16] Oliver Gurtler, Johannes Munster, and Petra Nieken. 2013. Information Policy in Tournaments with Sabotage. *The Scandinavian Journal of Economics* 115, 3 (2013), 932–966.
[17] Todd R. Kaplan and David Wettstein. 2015. The optimal design of rewards in contests. *Review of Economic Design* 19, 4 (2015), 327–339.
[18] Ernest K. Lai and Alexander Matros. 2006. Contest architecture with performance revelation. *Working Paper, University of Pittsburgh* (2006).
[19] Priel Levy. 2018. Optimal Contest Design for Multi-Agent Systems. In *Proceedings of the 2018 AAAI/ACM Conference on AI, Ethics, and Society*. ACM, 376–377.
[20] Priel Levy and David Sarne. 2018. Understanding Over Participation in Simple Contests. In *Proc. of AAAI*. 1571–1578.
[21] Priel Levy, David Sarne, and Yonatan Aumann. 2018. Tractable (Simple) Contests. In *Proc. of IJCAI*. 361–367.
[22] Priel Levy, David Sarne, and Igor Rochlin. 2017. Contest Design with Uncertain Performance and Costly Participation. In *Proc. of IJCAI*. 302–309.
[23] Xuyuan Liu and Jingfeng Lu. 2014. The effort-maximizing contest with heterogeneous prizes. *Economics Letters* 125, 3 (2014), 422–425.
[24] Adrian M. Masters. 1999. Wage Posting in Two-Sided Search and the Minimum Wage. *International Economic Review* 40, 4 (1999), 809–826.
[25] Alexander Matros. 2006. *Elimination tournaments where players have fixed resources*. Technical Report. University of Pittsburgh, Department of Economics.
[26] Benny Moldovanu and Aner Sela. 2001. The Optimal Allocation of Prizes in Contests. *American Economic Review* 91, 3 (2001), 542–558.
[27] Benny Moldovanu and Aner Sela. 2006. Contest architecture. *Journal of Economic Theory* 126, 1 (2006), 70–96.
[28] John Morgan. 2003. Sequential contests. *Public Choice* 116, 1-2 (2003), 1–18.
[29] Noam Peled, Sarit Kraus, et al. 2015. A study of computational and human strategies in revelation games. *Autonomous Agents and Multi-Agent Systems* 29, 1 (2015), 73–97.
[30] Alejandro Melo Ponce. 2018. Information Design in Contests. (2018). Working paper, Department of Economics Stony Brook University.
[31] David Sarne and Yonatan Aumann. 2014. Exploration costs as a means for improving performance in multiagent systems. *Annals of Mathematics and Artificial Intelligence* 72, 3-4 (2014), 297–329.
[32] David Sarne and Michael Lepioshkin. 2017. Effective Prize Structure for Simple Crowdsourcing Contests with Participation Costs. In *Proc. of HCOMP*. 167–176.
[33] Ron Siegel. 2009. All-Pay Contests. *Econometrica* 77, 1 (2009), 71–92.
[34] Rudi Stracke. 2013. Contest design and heterogeneity. *Economics Letters* 121, 1 (2013), 4–7.
[35] Richard H. Thaler and Cass R. Sunstein. 2008. Nudge: Improving decisions about health, wealth, and happiness. *Boston Yale University Press* (2008).
[36] Jun Zhang. 2008. *Simultaneous signaling in elimination contests*. Technical Report. Queen's Economics Department Working Paper.
[37] Jun Zhang and Ruqu Wang. 2009. The role of information revelation in elimination contests. *The Economic Journal* 119, 536 (2009), 613–641.