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Strategic effort allocation in online innovation tournaments

Indika Dissanayake[a,*], Jie Zhang[b], Mahmut Yasar[c], Sridhar P. Nerur[b]

[a] University of North Carolina Greensboro, PO Box 26170, Greensboro, NC 27402, United States
[b] The University of Texas at Arlington, 701 S West St, PO Box 19437 Arlington, TX 76019, United States
[c] The University of Texas at Arlington, 701 S West St, PO Box 19479 Arlington, TX 76019, United States

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ABSTRACT

Online innovation tournaments, such as those hosted by crowdsourcing platforms (e.g., Kaggle), have been widely adopted by firms to evolve creative solutions to various problems. Solvers compete in these tournaments to earn rewards. In such competitive environments, it is imperative that solvers provide creative solutions with minimum effort. This article explores the factors that influence the solvers' effort allocation decisions in a dynamic tournament setting. Specifically, comprehensive time variant data of teams that participated in crowdsourcing competitions on Kaggle were analyzed to gain insight into how solvers continually formulate strategies in light of performance feedback obtained through interim ranking. The results suggest that solvers strategically allocate their efforts throughout the contest to dynamically optimize their payoffs through balancing the probability of winning and the cost of expending effort. In particular, solvers tend to increase their efforts toward the end of tournaments or when they get closer to winning positions. Furthermore, our findings indicate that a last-minute surge in effort is more prevalent among high-skill solvers than in those with lower skill levels. In addition to providing insights that may help solvers develop strategies to improve their performance, the study has implications for the design of online crowdsourcing platforms, particularly in terms of incentivizing solvers to put forth their best effort.

1. Introduction

An innovation tournament refers to "a process that uncovers exceptionally good opportunities by considering many raw opportunities at the outset and selecting the best to survive" ([1] p.80). With rapid advances in Information Technologies, companies have increasingly adopted online innovation tournaments and contests to complement their in-house innovation projects, primarily to reduce costs without compromising on quality [2]. Online platforms facilitate tournament-based tasks in different areas, including software development, predictive analytics, scientific problem solving, and graphics and arts design [3]. For instance, the celebrated Netflix $1 M challenge attracted about 51,000 participants from 86 countries working, all vying to build a prediction model that would improve the accuracy of Netflix's movie recommendation algorithm by 10% [4]. In yet another competition, more than 57,000 online gamers, most of whom had no prior experience in molecular biology, contributed to the identification of the structure of a particular protein within three weeks, thus solving a problem that had defied researchers at the University of Washington for years [5,6]. It is apparent that such platforms provide a cost-effective means to exploiting the "wisdom of the crowds," thereby affording companies novel insights and solutions that may not be forthcoming with in-house projects alone.

The emerging literature on innovation tournaments has primarily focused on the optimal design of contests [7–10] or on the effects of individual characteristics and behaviors on contest outcomes [11–15], with the goal of maximizing payoffs. These studies provide evidence of the benefits of innovation contests, such as lower costs [13], lower risks [7], and higher quality of solutions [16], as well as affording multiple alternative solutions to challenging problems [9]. Prior studies (e.g., [17]) have carefully explored the impact of the characteristics and behaviors of solvers on the outcome of innovation tournaments under different competition conditions. Our paper extends these studies by examining how solvers strategically exploit the dynamics of these tournaments to wisely allocate efforts in an *un-blind* competition setting.

In innovation tournaments, solvers need to improve their skills and/or enhance their efforts to increase the likelihood of winning [9]. Although all the contestants expend effort to come up with a superior solution, it is only the best solution that is ultimately rewarded. Therefore, increasing effort in this setting can be costly, as a consequence of which contestants strategically decide how much effort to

* Corresponding author.
E-mail addresses: i_dissan@uncg.edu (I. Dissanayake), jiezhang@uta.edu (J. Zhang), myasar@uta.edu (M. Yasar), snerur@uta.edu (S.P. Nerur).

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exert over the duration of the contest in order to enhance their chances of winning. That is, participants may not necessarily put forth their best efforts to achieve their highest potential but rather strive just enough to accomplish their goal of providing a solution that is good enough to outperform their opponents and win the reward. Understanding these strategies would not only be helpful to contestants but also provide insights to platform providers. Seekers, or platform providers, do not have direct control over the extent to which contestants exert effort to solve the problem at hand. However, an understanding of the factors that influence how much effort solvers expend would help platform providers design competitions in such a way that solvers are persuaded to put forth their best efforts, thus increasing the likelihood of an optimal winning solution.

Our study used data from Kaggle.com, a large online predictive analytics tournament platform, to investigate how contestants formulate strategies for allocating efforts throughout a contest with a view toward improving their rankings and eventually securing a winning position. We identified two different strategies: *timing of efforts* (i.e., timing of submitting solutions) and *interim rank impact*. A key insight of our study is that solvers strategically delay their efforts until the end of the contest. Specifically, consistent with the findings in a complete information, sequential all-pay auction setting, our results showed that strong players strategically delay their efforts [18,19]. Furthermore, our finding that solvers strategize based on their interim rankings and subsequently exert more effort as they get closer to the winning position is consistent with the tenets of social comparison theory [20,21]. Thus, our study provides novel insight into the behavior of contestants as they respond to "game mechanics" such as interim rankings – a manifestation of leaderboards – and evolve strategies to strike the right balance between effort and performance.

In summary, this paper makes significant contributions to the sparse but emerging literature on innovation tournaments. First, this study is among a select few that have examined the effects of interim performance feedback in dynamic innovation tournaments. It extends the application of social comparison theory to online tournament platforms by showing that feedback can intensify the competition among top rankers. Interestingly, this is also an affirmation of the claim by advocates of gamification that "gaming elements" such as leaderboards (i.e., interim rankings) can engage and motivate participants (e.g., [22]). Second, it extends the timing strategies that were widely examined in the online auction literature to investigate the timing of efforts in a dynamic innovation tournament setting. Third, it shows that these timing strategies are contingent on the expertise of solvers by examining the moderating impact of their skills. Finally, to the best of our knowledge, ours is the first study to utilize temporally varying data, such as interim rankings and efforts, to elucidate how participants with differing skills continually strategize to balance their effort with the level of performance they desire.

The remainder of this paper is organized as follows. The next section reviews the literature related to innovation tournaments, interim ranking feedback, and timing strategies. It is followed by an articulation of our research model and the hypotheses that follow from it. Subsequently, we describe our data collection procedures and measures and then present our findings. Finally, we conclude with a discussion of the study's theoretical and managerial implications as well as its limitations, followed by directions for future research.

2. Literature review

This study is grounded in two distinct streams of research, namely Tournament- and Auction-related. In a general tournament setting (e.g., Sport tournaments such as weightlifting tournaments [23]), social comparison theory can be used to explain the impact of interim ranking on participants' efforts allocation patterns, while in auctions, timing strategies are more apparent. However, innovation tournaments in an un-blind setting, such as this study, have features of both tournaments and all-pay auctions. Since these features simultaneously impact solvers' effort allocation decisions in innovation tournaments, it may not be appropriate to explore them separately. Thus, we relied on theories from both the auction and tournament literature to study this effect. In this section, we first compare and contrast our study with prior work on innovation tournaments. Subsequently, we review pertinent literature and theories on interim ranking feedback (e.g., social comparison theory) and timing strategies (auction literature).

2.1. Innovation tournaments

A tournament is a "competition in which the outcome is determined by relative performance and the winner takes disproportionally larger award than the loser" ([24] p.578). It is also referred to as rank-ordered tournament since the performance is based on rank. Tournament theory has been applied in various contexts including academics, sports, sales, scientific work, and executive promotions [3].

In the online innovation tournament context, geographically distributed contestants compete with one another for monetary rewards. There is a growing body of literature on online innovation tournaments that primarily investigates the influence of contest characteristics (reward structure, problem characteristics, scope) and contestant characteristics (demographics, familiarity, skill) on the likelihood of finding a high-quality solution [11,25]. For example, Boudreau et al. [26] showed that, in general, increasing competition negatively impacts the performance of competitors, but induces a small group of competitors at the very top to exert more effort [3]. While adding more competitors reduces the incentive to solvers to exert more effort, it also increases the likelihood of finding an optimal solution [7]. Terwiesch and Xu [9] investigated how efficiencies in these competitions improved with changing award structure. Liu et al. [19] used a randomized field experiment in a crowdsourcing context to examine the effects of reward size and early high-quality submission on the number and quality of subsequent submissions. They found that the level of participation as well as the quality of submissions was positively associated with the size of the incentive. Furthermore, they demonstrated that experienced users were less likely to pursue tasks that already had high-quality solutions. While their study focused on decisions related to contest participation, our study draws attention to the underlying dynamics of the effort allocation process. Archak [11] showed that reputation systems influence strategic behaviors of solvers. Specifically, the study demonstrated that top-rated solvers used different strategies to successfully deter entry of their rivals in the same contest.

Most of these studies are based on blind, one-shot competition settings, with a few notable exceptions [25,27]. That is, solvers cannot see how good the solutions submitted by their rivals are, and they also get only one chance to submit a solution. Thus, the contestants primarily rely on the problem specification provided by the contest organizer at the beginning of the contest period.

Online "un-blind" innovation tournaments are becoming popular for finding creative solutions to diverse problems (e.g., Kaggle.com, logomyway.com, and taskcn.com). Moreover, some innovation tournaments allow solvers to make multiple solution submissions within the contest duration. Thus, over time solvers learn strategies to be successful in this "un-blind" and dynamic competition setting. However, to the best of our knowledge, the strategic behaviors of solvers have not attracted much attention in the innovation tournament literature. Among the few exceptions to this are [15,25,28,29]. Both Yang et al. [15] and Chen and Liu [29] showed that solvers who made their initial submission early or late within the contest duration have a higher chance of winning the competition, while Bockstedt et al. [28] showed that contestants who have a lower position in initial submission, or a higher level of separation between initial and last submission, are more likely to be successful. Yang et al. [15] argued that some solvers prefer to submit good solutions early in the contest to scare away other competitors as well as to receive early feedback from the seekers. In