Submission: The Perils of Exploration under Competition: A Computational Modeling Approach

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Workshop: Learning in the Presence of Strategic Behavior

We empirically study the interplay between *exploration* and *competition*. Systems that learn from interactions with users often engage in *exploration*: making potentially suboptimal decisions in order to acquire new information for future decisions. However, when multiple systems are competing for the same market of users, exploration may hurt a system's reputation in the near term, with adverse competitive effects. In particular, a system may enter a "death spiral", when the short-term reputation cost decreases the number of users for the system to learn from, which degrades the system's performance relative to competition and further decreases the market share.

We ask whether better exploration algorithms are incentivized under competition. We run extensive numerical experiments in a stylized duopoly model in which two firms deploy multi-armed bandit algorithms and compete for myopic users. We find that duopoly and monopoly tend to favor a primitive "greedy algorithm" that does not explore and leads to low consumer welfare, whereas a temporary monopoly (a duopoly with an early entrant) may incentivize better bandit algorithms and lead to higher consumer welfare. Our findings shed light on the first-mover advantage in the digital economy by exploring the role that data can play as a barrier to entry in online markets.

This paper continues the literature on "exploration and incentives", which in turn belongs to the area of "learning in the presence of strategic behavior". It is an experimental counterpart to Mansour et al. (2018), which has initiated the study of "exploration and competition" and obtained obtained a number of theoretical results with "asymptotic" flavor. While they considered a similar duopoly model and arrived at similar high-level conclusions, their details and assumptions are substantially different from ours for the sake analytical tractability, and their theorems have no direct bearing on our simulations. In comparison, we provide a more nuanced and "non-asymptotic" perspective, looking for substantial effects within relevant time scales. We plan a merged journal submission to a venue in economics or operations research.

References

Yishay Mansour, Aleksandrs Slivkins, and Steven Wu. Competing bandits: Learning under competition. In *9th Innovations in Theoretical Computer Science Conf. (ITCS)*, 2018.