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The Contest Game for Crowdsourcing Reviews

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Examples of popular Crowdsourcing Reviews platforms

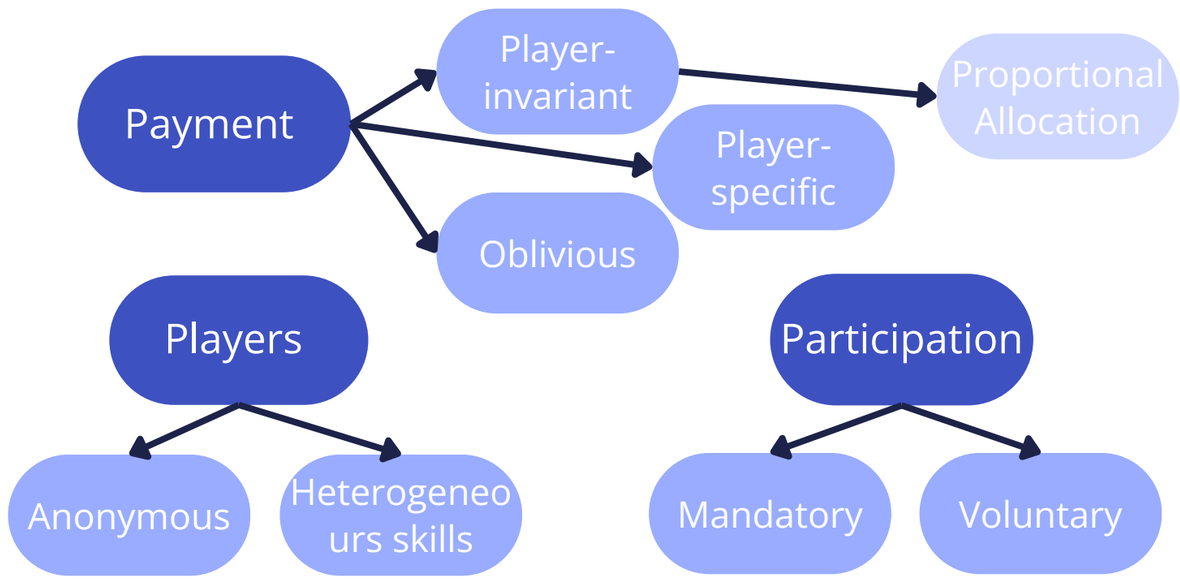
Introduction

Reviews are often gathered via crowdsourcing contests where participants choose how much effort to invest in their submissions. These models are relevant and increasingly popular, therefore it would be useful to understand them and forecast their evolution
The paper formalizes and analyzes different scenarios to check for equilibria, algorithmic tractability and ways to design these contests optimally to get the best result from independent reviewers.

Game Model

- **Players**: n reviewers with skill $s_i > 0$
- **Actions**: Choose review quality q_i in {1, ..., Q} (or $q_i = 0$ for *voluntary participation*)
- **Effort**: Each quality level q has cost f_q with $f_1 < ... < f_Q$ and $f_0 = 0$
- **Cost function**: Lambda(s_i, f_q), increasing with skill and effort
- **Payments**: $P_i(q)$ from a fixed reward pool (sum ≤ 1)
- **Utility**: $U_i(q) = P_i(q)$ - Lambda(s_i, f_{qi})

Scenarios



Result & Discussion

Existence of a Pure Nash Equilibrium with Player-Invariant and Oblivious Payments

Theoretical Guarantee:

The paper proves that contest games with player-invariant and oblivious payments always admit a pure Nash equilibrium, for any number of players, quality levels, and any skill-effort function. This is established via the construction of an exact potential function.

Tightness :
relaxing either player-invariance or obliviousness can lead to non-existence of equilibrium.

Payment Rule	Anonymous Players	Heterogeneous Players
Invariant+oblivious	✅ PNE exists	✅ PNE exists
Proportional	✅ (1 or 2 PNE)	❌ may not exist
Player-specific	❌ may not exist	❌ NP-complete to check

Other relevant results

FIP with Proportional Allocation:

The game with proportional payments and anonymous players has the Finite Improvement Property (FIP), guaranteeing convergence to pure Nash equilibria.

Contigufication Lemma:

Any pure Nash equilibrium can be transformed into a contiguous one, where higher-skilled players are assigned to lower-quality reviews.

PNE and Efficient Computation under Concave Payments

Under three-discrete-concavity condition, a PNE exists and can be found with an algorithm where higher-skilled players assume lower-effort roles, reducing profiles space.

Open problems

- Is computing mixed Nash equilibria PPAD-complete?
- Is best-response computation NP-hard in contest games?
- Do pure Bayes-Nash equilibria exist in incomplete information settings?

References

- M. Mavronicolas and P. G. Spirakis. The Contest Game for Crowdsourcing Reviews, page 71–89. Springer Nature Switzerland, 2023.

Luca Vitaterna, Matija Jacovak, Matteo Salari