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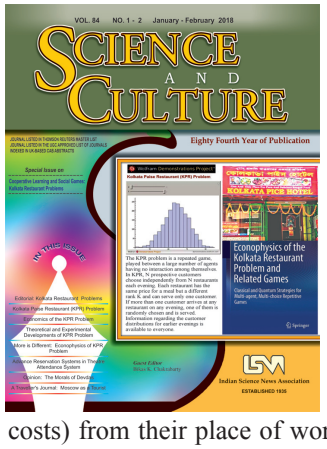
EDITORIAL

KOLKATA RESTAURANT PROBLEMS



In Kolkata, long back, there were very cheap and fixed price "Paise Restaurants" (also called "Paise Hotels"; Paise is, rather was, the smallest Indian coin) which were very popular among the daily labourers in the city. During lunch hours, these labourers used to walk down (to save the transport costs) from their place of work to one of these restaurants. These Paise Restaurants would prepare every day a fixed (small) number of such dishes, and if several groups of labourers would arrive any day to the same restaurant, only one group perhaps would get their lunch and the rest would miss lunch that day. There were no cheap communication means (mobile phones) for mutual communications, before deciding for the respective restaurants. Walking down to the next restaurant would mean failing to report back to work on time! To complicate this collective learning and decision making problem, there were indeed some well-known rankings of these restaurants, as some of them would offer tastier items compared to the others (at the same cost, paisa, of course) and people would prefer to choose the higher rank of the restaurant, if not crowded! This "mismatch" of the choice and the consequent decision not only creates inconvenience for the prospective customer (going without lunch), would also mean "social wastage" (excess unconsumed food, services or supplies somewhere).

A similar problem arises when the public administration plans and provides hospitals (beds) in different localities, but the local patients prefer "better" perceived hospitals elsewhere. These "outsider" patients then compete with the local patients and have to choose other suitable hospitals elsewhere. Unavailability of the hospital beds in the over-crowded hospitals may be considered as insufficient service provided by the administration, and consequently the unattended potential services will be considered as social wastage.

The Kolkata Paise Restaurant (KPR) problem is a repeated game, played among a large number of players or agents having no communication or interaction among themselves. In KPR, prospective players (customers/agents) choose from restaurants each evening (time) simultaneously or in parallel decision mode. There is no budget constraint to restrict the choice (and hence the solutions). Each restaurant has the same price for a meal but has a different rank, which is agreed upon by all the customers or players.

This kind of games, anticipating the possible strategies of the other players and acting accordingly, is very common in society. Here, the number of choices need not be very limited (as in the standard binary-choice

formulations of most of the games) and the number of players can be truly large! Also, these are not necessarily one shot games, rather the players can learn from past mistakes and improve on the selection of their strategies for the next move. These features make the games extremely intriguing and also versatile, with major collective or social emerging structures, not comparable to the standard finite choice, non-iterative games among finite number of players. Such repetitive collective social learning for a community sharing past knowledge for the individual intention to be in minority choice side in successive attempts are modelled by the "Kolkata Paise Restaurant" (KPR) Problem or, in short, by the "Kolkata Restaurant Problem".

The Kolkata Paise Restaurant (KPR) problem is a repeated game, played among a large number of players or agents having no communication or interaction among themselves. In KPR, prospective players (customers/agents) choose from restaurants each evening (time) simultaneously or in parallel decision mode. There is no budget constraint to restrict the choice (and hence the solutions). Each restaurant has the same price for a meal but has a different rank, which is agreed upon by all the customers or players. For simplicity, we assume, each restaurant can serve only one customer (generalization to any fixed number of daily services for each would not change the complexion of the problem or game. If more than one customer arrives at any restaurant on any evening, one of them is randomly chosen and is served and the rest do not get dinner that evening. Information regarding the prospective customer or crowd distributions, for the earlier evenings (up to a finite memory size) is made available to everyone. Each evening, based on own learning and the developed (often mixed) strategies, each customer chooses a restaurant independent of the others. Each customer wants to go to the restaurant with the highest possible rank while avoiding a crowd so as to be able to get dinner there. Both from individual success and social efficiency perspective, the goal is to "learn collectively" in "reasonable" time (or iterations of the game) the most successful strategies for the individuals, thereby leading to highest social efficiency of services.

The Kolkata Paise Restaurant (KPR) problem seems to have a trivial solution: suppose that somebody, say a dictator (who is not a player), assigns a restaurant to each person and asks them to shift to the next restaurant cyclically, on successive evenings. The fairest and most efficient solution: each customer gets food on each evening (if the number of plates or choices is the same as that of the customers or players) with the same share of the rankings as others, and that too from the first evening (minimum evolution time). This, however, is NOT a true solution of the KPR problem, where each customer or agent decides on his or her own every evening, based on complete information about past events. In KPR, the customers try to evolve a learning strategy to eventually get to something like the dictated solution. The time for the evolution needs also to be optimized; for example, a very efficient strategy, having convergence time which grows linearly with the number of players, is unsuitable for must of the social games, as our life span is finite, while the number of players or competitors can not be bounded (in any democracy)! There have been many attempts, using tricks from statistical physics, quantum physics, and computer sciences, to search for the optimal strategies. Very recently, a book entitled *Econophysics of the Kolkata Restaurant Problem and Related Games: Classical and Quantum Strategies for Multi-agent, Multi-choice Repetitive Games*, by B. K. Chakrabarti, A. Chatterjee, A. Ghosh, S. Mukherjee, B. Tamir, has been published by Springer, Switzerland (2017).

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In this special issue of Science and Culture, we have presented several introductory articles on KPR. The article by Asim Ghosh and Sudip Mukherjee traces the development of the KPR problems so far, through the

original sources or papers. The article by Priyodorshi Banerjee, Manipushpak Mitra, and Conan Mukherjee introduces the the game-theoretic structure of the KPR problem, the article by Kiran Sharma, Anamica, Anindya Sundar Chakrabarti, Anirban Chakraborti and Sujoy Chakravarty introduces the readers to both theoretical and experimental studies in KPR, indicating how it can serve as a prototype for broader class of resource allocation problems among large number of competing agents. It may be mentioned that the first two published papers on KPR had Anindya, Asim and Manipushpak as coauthors and therefore these three articles are from the originators and their colleagues. Boaz Tamir, in his inspiring article, discusses both classical and quantum strategies to solve KPR problem, and also discusses how it can be viewed as a cradle for a majority of econophysical problems. Finally, Michele Bisceglia discusses how KPR formulation can be used for theatre attendance in advance reservation systems.

These brief survey papers in this special issue on the KPR problem will surely help the readers to appreciate how the KPR model is developing as a very important benchmark: It is literally at the cross-road of a number of prominent disciplines ranging from game theory to multi-variable optimization algorithms in computer science, with enormous applicability to real-life coordination problems such as job-scheduling, on-call taxi-services, hotel rentals, and so on. This special issue had been planned in extreme hurry, in order to meet a (financial!) deadline. As a Guest Editor for this special issue, I am extremely grateful to all our contributors. This is not only for their wonderful and important contributions to this issue, but more importantly, for agreeing and submitting their contributions within about two months of receiving our invitation mails (naturally, several of the invitees could not contribute)! I am so happy to record my heartfelt appreciations for all their kind support. Hope, the readers will enjoy the issue.

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Guest Editor

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