Optimization of Group Division Method for Rock-Paper-Scissors Game Considering Efficiency and Fairness

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When many participants are involved, rock-paper-scissors tournaments can take numerous matches to complete. Prior studies attempted to reduce the number of matches by appropriately distributing the participants. However, they failed to address the issue of unfairness due to the uneven distribution. Therefore, this study defines efficiency and fairness metrics to find the optimal sequence of group division. The efficiency metric is defined as the expected number of matches until the final winner is decided and is calculated using the Markov chain. The fairness metric is defined as the sum of the standard deviation of the probabilities that each participant will continue in each round of the tournament. By using these metrics, this study defines the evaluation function to facilitate a comparative analysis to determine the optimal sequence. The optimal sequence found in this study shows a better balance between efficiency and fairness. Compared to the average of random sequences, the optimal sequence improved the efficiency metric by 5.76% and the fairness metric by 71.84%. Although the optimal sequence was slightly slower than the fastest sequence by 1.16%, the fairness metric of the optimal sequence was 40.12% better. These insights are valuable in designing tournament organizations or group division systems, where balancing efficiency and fairness is crucial. For instance, the results can be applied to improve the sports league system or to refine divide-and-conquer algorithms.

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