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Probabilistic Penalty Approaches the Balanced Transportation Problem Using the Ant Colony Algorithm

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Supply chain management and logistics depend on operations research (OR), which focuses on the effective distribution of resources to either maximize profits or minimize overall costs. Identifying practical solutions for transportation-related problems is one of the most important problems in this area. Standard methods are helpful for minimization problems because they are deterministic and cost centered, but they may not be as flexible or adaptive. In order to solve balanced transportation problems without the use of artificial balancing techniques like dummy rows or columns, we present a novel heuristics algorithm in this study that makes use of probability based decision making and fixed penalty values. Building a probability matrix that represents the desirability of every potential allocation is the first step in the suggested approach. To achieve this, the difference between the cost of each individual cell and the highest cost in the matrix is normalized. The difference between the highest and next highest probabilities is then used to compute penalties for each row and column. There is no need for frequent recalculations because these penalties stay the same throughout the allocation process. The algorithm chooses the cell with the highest probability within each iteration after identifying the row or column with the uniquely highest penalty (ignoring ties). When there are ties, the cell with the highest practical allocation and the lowest cost is chosen. Until all supply and demand requirements are met. The total cost of transportation is then computed to assess the final solution. The results show that this approach avoids needless complexity, like recalculating penalties or using dummy variables, while still producing effective and reliable solutions. In the results, my method reduced transportation costs by an average of about 2.7% compared to VAM, with solutions remaining within 98.7% of the optimal value across 20 test cases.

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