Algorithms for online marketplaces

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In this study an algorithm is presented to optimize seller selection in an online marketplace with respect to the total cost to be paid. The ultimate goal of our work was that the developed method could be utilized when customer demand involves purchasing a large number of items. Certain features can dictate that the task is not decomposable to some subproblems, specified by the number of items to be purchased. In fact selecting sellers for each required item is not necessarily independent in case there is a certain symmetry breaking property. Said property manifests in the form that the item costs for each seller will depend on the number of total products selected from the particular source. It usually results in a step function structure when prices plotted, with jumps (or reductions) located at certain values only. What otherwise would be as simple as picking the cheapest seller for each item, becomes now an entangled set of choices. Reaching a so-called price jump is very intriguing in terms of the total cost. Therefore it necessitates a somewhat more sophisticated way for seller selection.

The algorithm presented in the work is partly a combination of simulated annealing (SA) and Monte-Carlo tree search (MCTS), hence the proposed name SA-MCTS. The idea was motivated by the domain structure of the state space, which provided the basis for the optimization procedure. This basis has been chosen as the combinations of pairs of sellers and their corresponding price jumps. Thus a hierarchical structure could be identified between the states, which led us to the consideration of a tree-search-like approach. Another important property of the underlying state space is that in general, feasibility of nodes decreases as we go higher on the tree. That is an arbitrary node as a combination of many pairs, are less likely to be feasible. Resulting that the hierarchical structure is partnered up with an increasing importance for exploiting known routes as the algorithm proceeds. This could be captured by applying an annealing schedule on the parameter controlling the ratio between horizontal exploration of new states and vertical exploitation. Fortunately both constructing optimization method can be adjusted to the given problem, with many hyperparameters to be defined beforehand. In return though creating a general algorithm capable of solving any related problems on different areas is wishful thinking. Nevertheless SA-MCTS can provide a way for optimization whenever the domain structure of the state space is similar.