Automating Food Drop: The Power of Two Choices for Dynamic and Fair Food Allocation

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Food waste and food insecurity are two closely related pressing global issues. Food rescue organizations worldwide run programs aimed at addressing the two problems. In this paper, we partner with a non-profit organization in the state of Indiana that leads *Food Drop*, a program that is designed to redirect rejected truckloads of food away from landfills and into food banks. The truckload to food bank matching decisions are currently made by an employee of our partner organization. In addition to this being a very time-consuming task, as perhaps expected from human-based matching decisions, the allocations are often skewed: a small percentage of the possible recipients receives the majority of donations. Our goal in this partnership is to completely automate Food Drop. In doing so, we need a matching algorithm for making real-time decisions that strikes a balance between ensuring fairness for the food banks that receive the food and optimizing efficiency for the truck drivers. In this paper, we describe the theoretical guarantees and experiments that dictated our choice of algorithm in the platform we built and deployed for our partner organization. We develop a new model for dynamic fair division with two-sided preferences. There is an undirected, weighted graph, whose nodes represent counties, a subset of which have food banks that can receive donations, edge weights represent distance, and node weights represent the food-insecure population. Drivers appear over time, one in each step, and need to be matched, immediately and irrevocably, to a food bank. Drivers have a random origin node, a random final destination node, and a donation of random value. Our goal is to balance driver efficiency (drivers should not have to drive a lot) with fairness (every food bank should receive value proportionately to the food-insecure individuals it serves). We give matching upper and lower bounds that completely characterize this trade-off. Our work also makes contributions to the literature on load balancing and balls-into-bins games, that might be of independent interest. Specifically, we study the allocation of m weighted balls into n weighted bins, where each ball has two non-uniformly sampled random bin choices, and prove upper bounds, that hold with high probability, on the maximum load of any bin.

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