Manipulating Waiting-Plus-Detour-Time Mechanisms for Pickup and Delivery Problems

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We look at centralized problems where a fleet of vehicles services a number of transport customers. Customers have quasi-linear valuations for their waiting plus detour times. For example, a given customer may want to wait at most 5 minutes for a vehicle, detour at most 10 minutes in a vehicle, or that their waiting plus detour time be at most 15 minutes. We look at the mechanism that minimizes the total waiting plus detour time for all customers, i.e. the welfare. Customers can report false valuations and, thus, try to manipulate this mechanism. We make the following three contributions in this regard.

1) We show that a given customer can via manipulations strictly increase the welfare and strictly decrease their own waiting plus detour time. Such manipulations strictly increase the total fleet operating cost. However, we prove that deciding on such manipulations is NP-hard. Therefore, customers may give up such manipulations.

2) Nevertheless, we measure how much the welfare can increase due to strategic behavior. We do this by adapting the price of anarchy to our setting and calculating it in some edge cases. This gives us a lower bound on how much additional fleet operating cost the central authority needs to pay for compensating this increase.

3) Finally, we show that a given customer can via manipulations also strictly decrease both the welfare and their own waiting plus detour time. Such manipulations strictly decrease the total fleet operating cost and, thus, are advantageous for the central authority. In response, we consider computing a Nash equilibrium of minimum such cost.