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Tariff zone planning for public transport companies

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Abstract We introduce the revenue maximizing tariff zone planning problem. We present a novel model formulation and show by numerical examples that real world instances are solvable (up to optimality) using GAMS/CPLEX. We show the applicability by a real world case study of the San Francisco Bay Area.

Keywords public transport tariff · districting · contiguity · revenue management · customer demand

In contrast to the representation in scientific literature we find the (spatial) design of tariff systems in public transportation to be very important in terms of managerial relevance: by appropriate design of the tariff system a public transport company is expected to increase its revenue remarkably. The counting zones tariff system is the prevailing system in metropolitan areas, such as London, Boston, and Perth. For the counting zones tariff system, the corresponding tariff is determined by the product of the number of zones passed on the trip from origin to destination and the price per zone. The price per zone denoted as fare might be decreasing in the number of zones passed. In this paper, we contribute to the scant literature on public transport tariff zone design by a new model for the tariff zone design problem. The objective is to maximize the expected total revenue (demand x tariff) taking into account contiguous tariff zones and discrete fare levels. The literature on public transport demand provides strong evidence that public transport customers

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are price sensitive. Demand as a function of tariff (i.e., demand depends on the tariff to be paid) - is measured as the number of public transport trips between origin and destination. Customers are assumed to choose the time-shortest-path (which is confirmed by numerous empirical studies). For a given fare we compute the expected revenue for each origin-destination pair and the number of tariff zones passed. As a consequence we are able to model the original non-linear problem as a MIP. The problem has to be solved for each fare level separately. Contiguity is a complex task in spatial optimization. Here, contiguity is achieved by using primal and dual graph information. Therefore, we consider flow conservation constraints using the dual graph of the public transport graph. Our approach is general in the vein that demand can be determined by any arbitrarily chosen demand model (i.e., no assumptions about the functional form have to be made). We perform a series of numerical investigations using GAMS/CPLEX and artificial data to show the applicability of our approach. Further, we employ our approach to the San Francisco Bay Area, California using a simple version of the MTC Travel Model One as our demand model.