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Active Preference Elicitation via Adjustable Robust Optimization

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We consider the problem faced by a recommender system which seeks to offer a user with unknown preferences their favorite item among a potentially infinite collection. Before making a recommendation, the system has the opportunity to elicit the user's preferences by making a moderate number of queries. Each query corresponds to a pairwise comparison, in the spirit of choice-based conjoint analysis. We take the point of view of a risk-averse recommender system which only possesses limited, set-based, information on the user utility function. We propose an exact robust optimization formulation of the problem which integrates the preference elicitation and recommendation phases. We investigate two settings: \emph{a)} a \emph{static} setting, where all queries are made at once and \emph{b)} an \emph{adaptive} setting, where queries are selected sequentially over time in an adaptive fashion. For the static case, where the active preference elicitation problem takes the form of a two-stage robust optimization problem with decision-dependent information discovery, we provide an enumeration-based algorithm and also an equivalent reformulation in the form of a mixed-binary linear program which we solve via column-and-constraint generation. For the adaptive setting, where the active preference learning problem takes the form of a multi-stage robust optimization problem with decision-dependent information discovery, we leverage our enumeration-based framework and propose a folding horizon algorithm which selects queries in a greedy fashion. We evaluate the performance of our approach on both synthetic and real-world data from the U.S. homeless youth population where we learn the preferences of policy-makers in terms of characteristics (fairness-efficiency trade-offs) of a policy for allocating housing resources. Our framework is shown to outperform state-of-the-art techniques from the literature.