Representing & Reasoning with Qualitative Preferences: Tools and Applications

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Many applications call for techniques for representing and reasoning about preferences, i.e., relative desirability over a set of alternatives. Such preferences are usually succinctly expressed over a set of attributes describing the alternatives. For example, a student's preference for one course over another may be influenced by his preference for the topic, the time of the day when the course is offered, etc. Especially in policy making, defense, etc. when the stakes are high, such preferences may often be qualitative (i.e., relative ordering as opposed to quantitative) and possibly conditional.

An important problem in reasoning with multi-attribute qualitative preferences is dominance testing, i.e., to find if one alternative (assignment to all attributes) is preferred over another. This problem is hard (PSPACE-complete) in general for well-known qualitative conditional preference languages, and hence such preference formalisms have found limited use in practice. We provide two practical approaches to dominance testing. First, we study a restricted unconditional preference language, and provide a dominance relation that can be computed in polynomial time by evaluating the satisfiability of an appropriately constructed logic formula. Second, we show how to reduce dominance testing to reachability analysis in an "induced preference graph", and how dominance testing can be reduced to model checking by a suitable translation of the preferences over alternatives into a Kripke structure.

Other reasoning tasks with qualitative preferences include consistency checking (testing for cyclic induced preferences), ordering (computing a sequence of next-preferred solutions in descending order of preference), equivalence (or subsumption) checking (testing if two the preferences of two agents induce the same set of preferences over alternatives (or if one induces a subset of the other). We show how these reasoning tasks can be efficiently performed for comparative preferences. Finally, we illustrate applications of the developed techniques within and beyond computing including software engineering, services, security, sustainable and engineering design.

Dr. Ganesh Ram Santhanam is a postdoctoral research associate at the Department of Computer Science. He received his PhD from the department in 2010 under the supervision of Dr. Vasant Honavar, and has since continued to work with Dr. Samik Basu and Dr. Giora Slutzki on related research areas. His research interests include formal methods, software engineering (model checking), artificial intelligence (knowledge representation), and decision theory. His research has appeared in conferences and journals such as KR, AAAI, and JAIR, and the results of his work have been applied to real problems in civil engineering and sustainable design.

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