Design Preference Elicitation, Identification and Estimation

by

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For my parents

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ABSTRACT

Understanding user preference has long been a challenging topic in the design research community. Econometric methods have been adopted to link design and market, achieving design solutions sound from both engineering and business perspectives. This approach, however, only refines existing designs from revealed or stated preference data. What is needed for generating new designs is an environment for concept exploration and a channel to collect and analyze preferences on newly-explored concepts. This dissertation focuses on the development of querying techniques that learn and extract individual preferences efficiently. Throughout the dissertation, we work in the context of a human-computer interaction where in each iteration the subject is asked to choose preferred designs out of a set. The computer learns from the subject and creates the next query set so that the responses from the subject will yield the most information on the subject's preferences. The challenges of this research are: (1) To learn subject preferences within short interactions with enormous candidate designs; (2) To facilitate real-time interactions with efficient computation.

Three problems are discussed surrounding how information-rich queries can be made. The major effort is devoted to *preference elicitation*, where we discuss how to locate the most preferred design of a subject. Using efficient global optimization, we develop search algorithms that combine exploration of new concepts and exploitation of existing knowledge, achieving near-optimal solutions with a small number of queries. For design demonstration, the elicitation algorithm is incorporated with an online 3D car modeler. The effectiveness of the algorithm is confirmed by real user

tests on finding car models close to the users' targets. In *preference identification*, we consider designs as binary labeled, and the objective is to classify preferred designs from not-preferred ones. We show that this classification problem can be formulated and solved by the same active learning technique used for *preference estimation*, where the objective is to estimate a preference function. Conceptually, this dissertation discusses how to extract preference information effectively by asking relevant but not redundant questions during an interaction.