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User-centric Preference-based Decision Making

Tese de Doutorado

Thesis presented to the Programa de Pós-Graduação em Informática of the Departamento de Informática, PUC-Rio as partial fulfillment of the requirements for the degree of Doutor em Informática.

Advisor: Prof. Carlos José Pereira de Lucena

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To my parents, Daltro and Suzana.
To my brothers, Gustavo and Matthias.
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Resumo

Nunes, Ingrid Oliveira de; Lucena, Carlos José Pereira de. **Tomada de Decisão baseada em Preferências e centrada no Usuário**. Rio de Janeiro, 2012. 298p. Tese de Doutorado — Departamento de Informática, Pontifícia Universidade Católica do Rio de Janeiro.

A escolha de uma entre um conjunto de opções disponível normalmente requer a resolução de *trade-offs*, contudo esperar que as pessoas avaliem cada uma das opções de um grande conjunto pode ser inviável devido ao tempo e ao esforço cognitivo necessários para realizar tal análise, fazendo com que elas fiquem frequentemente insatisfeitas com suas escolhas. Sistemas de software podem dar suporte à tomada de decisão humana ou mesmo automatizar esse processo, entretanto existem muitos desafios que estão associados com o oferecimento de tal suporte. Esta tese lida, em particular, com três destes desafios: (i) como representar preferências dos usuários; (ii) como raciocinar sobre estas preferências e tomar decisões; e (iii) como justificar tais decisões. Diferentes abordagens têm sido propostas para a representação e raciocínio sobre preferências qualitativas, mas estas abordagens lidam com um conjunto restrito de tipos de preferências, e portanto não são capazes de processar preferências fornecidas por usuários em muitos cenários realistas. Nesta tese, apresentam-se três principais contribuições. A primeira delas consiste de um novo metamodelo de preferências, o qual foi desenvolvido de acordo com um estudo sobre a expressão de preferências, permitindo a representação de preferências em alto-nível. Segundo, uma nova técnica de tomada de decisão automatizada é proposta, a qual escolhe uma opção de um conjunto de opções disponível baseada em preferências expressas em uma linguagem construída de acordo com o metamodelo proposto, explorando termos da linguagem natural, tais como atos de fala expressivos. A técnica vai além das preferências fornecidas para tomar a decisão através da incorporação de princípios da psicologia, que focam como os humanos tomam decisões, já que as preferências fornecidas tipicamente não são suficientes para resolver *trade-offs* entre as opções disponíveis. Terceiro, apresenta-se uma técnica de geração de explicação, que utiliza modelos construídos pela técnica de tomada de decisão para justificar escolhas, e segue diretrizes e padrões que foram derivados de um estudo sobre explicações a respeito de escolhas, também realizado no contexto desta tese. Um estudo com usuários foi feito para avaliar a abordagem, o qual mostra que (i) a linguagem de preferências é adequada para usuários expressarem suas preferências, que (ii) a técnica de tomada de decisão faz escolhas que os usuários consideram de alta qualidade, e que (iii) as explicações fornecidas permitem que usuários entendam por que a escolha foi feita, bem como melhora a confiança na decisão tomada.

Palavras-chave

Tomada de Decisão. Representação de Preferências. Raciocínio sobre Preferências. Explicação a Usuários. Raciocínio Humano. Sistemas de Suporte à Decisão.

Abstract

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Choosing from a set of available options often requires resolution of trade-offs but it can be unfeasible for humans to carefully evaluate each option of a large set due to the required time and cognitive effort. Consequently, they are often unsatisfied with their choices. Software systems can support human decision making or even automate this process, but there are many challenges associated with the provision of such support. In this thesis we deal in particular with three of them: (i) how to represent user preferences; (ii) how to reason about preferences and make decisions; and (iii) how to justify such decisions. Different approaches have been proposed for representing and reasoning about qualitative preferences, but they address a restricted set of preference types, and therefore are not able to process preferences provided by users in many realistic scenarios. This thesis provides three main contributions. First, we introduce a new preference metamodel founded on a study of how humans express preferences, allowing the representation of high-level preferences. Second, we propose an automated decision making technique, which chooses an option from a set available based on preferences expressed in a language based on our metamodel, exploiting natural-language terms. Our technique goes beyond the provided preferences to make a decision with the incorporation of psychology principles, which concern how humans make decisions, as the provided preferences are typically not enough to resolve trade-offs among available options. Third, we present an explanation generation technique, which uses models built by our decision making technique to justify choices, and follows guidelines and patterns that we derived from a study of choice explanation. A user study was performed to evaluate our approach, which shows that (i) our preference language is adequate for users to express their preferences, (ii) our decision making technique makes choices that users consider as having good quality, and (iii) the provided explanations allow users to understand why the choice was made and improves the confidence in the decision.

Keywords

Decision making. Preference Representation. Preference Reasoning. User Explanations. Human Reasoning. Decision Support Systems.

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Abbreviation and Acronym List

AI artificial intelligence

AMVF additive multi-attribute value function

AVPO attribute value partial order

BMO Best-Matches-Only

CSP Constraint Satisfaction Problem

CIT conditional importance table

CPT conditional preference table

DAG directed acyclic graph

EAF Extended Argumentation Framework

EBNF Extended Backus Naur Form

ES Expert System

GA generalised additive

GAI generalised additive independence

GEA Generator of Evaluative Arguments

GQM goal-question-metric

IVA Interpretive Value Analysis

MAUT Multi-Attribute Utility Theory

OAPM Options-Attribute Preference Model

OVF optimal value function

PSM Preference Satisfaction Model

SCSP Soft Constraint Satisfaction Problem

SE Software Engineering

SLO Soft-constraint Lexicographic Ordering

SVM Support Vector Machines

UML Unified Modeling Language

UF utility function