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Multicriteria Decision Aid: Evaluation and Comparison of Main Techniques/Tools

Anabela Teseso, Cristina Seixedo
Production and Systems Department
Engineering School
University of Minho – Portugal

anabelat@dps.uminho.pt

Topics

- Introduction
- Multicriteria Decision Aid
- Main MCDA Software Tools
- Conclusions and Future Research

Introduction

- Companies increasingly pay more attention to the decisions that have to be made.
- Currently there are several software packages on the market to help make decisions.
- What is the best software to solve a specific problem?
- The goal of this work is to help on that choice.

Multicriteria Decision Aid

Introduction to MCDA

- Whenever a problem has more than one solution and a choice must be made on which one to adopt, we have a decision problem (Tereso, 2007).
- The decision is an effort to solve problems of conflicting objectives, which presence prevents the existence of the optimal solution and leads to demand the best compromise (Zeleny, 1982).
- A multicriteria decision problem is a complex problem which, as the name suggests, involves several criteria and the evaluation of several alternatives.

Multicriteria Decision Aid

Basic Concepts of the Decision Theory

- Decision-makers: It is a group of individuals that carry out choices and have preferences as a whole.
- Analyst: The analyst is the agent that has the role of selecting the model to be used, the information necessary to model and interpret the results and explain the decision mechanism of the model chosen (Rogers et al., 1999).
- Model: It is a set of mathematical operations that represent the tastes and views of the decision makers, leading to the achievement of the desired result.

Multicriteria Decision Aid

Basic Concepts of the Decision Theory

- Actor: Roy (1985) and Bana e Costa (1993) define actor as a person or group of persons who, in a decision-making process, directly or indirectly influence the decision.
- Alternatives: A set of alternatives is a set of choices.
- Criteria: Tools that allow comparing the actions in relation to views of each decision maker (Roy, 1996).
- Objectives: Demonstration of something that somebody wants to reach (Keeney, 1992).

Multicriteria Decision Aid

Classification of Multicriteria Methods

- According to Vincke (1992), most of the researchers or authors divide the MCDA in three families of approaches:
  - American School or School of the MultiAttribute Utility Theory (MAUT).
  - French School or European school or methods of outranking and synthesis.
  - Interactive methods or multiobjective mathematical programming models.
- The French School directs its study to methodologies where the personal preferences of decision makers have less influence on the alternative chosen.
- The American School seeks methods to better explain the preferences of the decision maker, which can have a major influence on the final choice.

Multicriteria Decision Aid

Classification of Multicriteria Methods

- A good decision will only be possible if there is balance between these two influences.
- Methods of the French School
  - ELECTRE family methods (ELimination Et Choix Traduisant la REalité) which stems from the pioneering work of Roy (1985).
  - PROMETHEE (PReference ranking Organization METHod for Enrichment Evaluations) method developed by Brans and Vincke (1985).

Multicriteria Decision Aid

Classification of Multicriteria Methods

- Methods of the American School
  - Multiattribute Utility Theory of Keeny and Raiffa (1993), that explicitly addresses the value tradeoffs in multiobjective decisions.
  - AHP (Analytic Hierarchy Process), developed by Thomas Saaty in the mid 1970s, that is based in pairwise comparisons between alternatives (Saaty, 1980).

Main MCDA Software Tools

Introduction

- In the literature there are many methods for solving multicriteria decision analysis problems, and a wide range of software to implement them.
- Many of the tools are still in experimental phase, combined with academic research.
- So to do a survey of software in this area is a difficult task, not only because of the rapid developments in computer science, but also because its commercialization is associated with its author or the university that developed it.

Main MCDA Software Tools

Introduction

- The MCDA software reaches several levels of the decision making process: structure of the problem, modeling of the preferences and providing the solution.
- In this study the software analyzed to help solve MCDA problems was divided into six categories: Qualitative Problem Structuring, General Multiple Attribute Decision Making, General Multiple Objective Decision Making, Multiple Criteria Sorting Problems, Specific Applications Software and Group Decision Support. A similar approach was used in Weistroffer et *al*. (2005).

Main MCDA Software Tools

Qualitative Problem Structuring

- The software in this category implements the initial stages of the decision making process: exploration and formulation of the problem.
  - DECISION EXPLORER: http://www.banxia.com/dexplore/index.html .

Main MCDA Software Tools

General Multiple Attribute Decision Making

- The software in this category deals with any problem of decision, where it is necessary to choose a finite set of alternatives, by a set of attributes.
  - CRITERIUM DECISION PLUS: http://www.infoharvest.com/ihroot/infoharv/products.asp#CDP30
  - DAM (Decision Analysis Module) (Podinovski, 1999)
  - DECISION DECK: http://www.decision-deck.org/index.html
  - DECISION LAB: http://www.visualdecision.com/
  - ELECTRE IS: http://www.lamsade.dauphine.fr/english/software.html#elis
  - ELECTRE III-IV: http://www.lamsade.dauphine.fr/english/software.html#el34
  - EQUITY: http://www.catalyze.co.uk/products
  - EXPERT CHOICE: http://www.expertchoice.com/

Main MCDA Software Tools

General Multiple Attribute Decision Making

- GMAA (Generic MultiAttribute Analysis): http://www.dia.fi.upm.es/~ajimenez/GMAA
- GRIP (Figueira et al., 2007)
- HIVIEW: http://www.catalyze.co.uk/products
- IDS: http://www.e-ids.co.uk/
- LOGICAL DECISIONS: http://www.logicaldecisions.com/
- MACBETH: http://www.m-macbeth.com/index.html
- MACMODEL: http://www.civil.ist.utl.pt/~lavt/software.html
- M&P: MAPPAC (Matarazzo, 1986) and PRAGMA (Matarazzo, 1988)
- MIIDAS (Siskos et al., 1999)
- MINORA (Siskos et al., 1993)
- MUSTARD (Beuthe and Scannella, 1999)

Main MCDA Software Tools

General Multiple Attribute Decision Making

- NAIADE: http://alba.jrc.it/ulysses/voyage-home/naiade/naisoft.htm
- ON BALANCE: http://www.quartzstar.com/
- PREFCALC: http://garage.maemo.org/projects/prefcalc/
- PRIAM (PRogramme utilisant l'Intelligence Artificielle en Multicritère) (Levine and Pomerol, 1986)
- PRIME DECISIONS: http://www.sal.tkk.fi/English/Downloadables/prime.html
- REMBRANDT (Lootsma, 1992)
- RPM (Robust Portfolio Modeling): http://www.rpm.tkk.fi/index.html
- SANNA: http://nb.vse.cz/~jablon/sanna.htm
- SMAA.fi: http://www.smaa.fi/index.php
- TOPSIS: http://www.stat-design.com/topsis-sdi.php

Main MCDA Software Tools

General Multiple Attribute Decision Making

- UTA PLUS: http://www.lamsade.dauphine.fr/english/software.html#uta+
- VIP ANALYSIS: http://www4.fe.uc.pt/lmcdias/english/vipa.htm
- VISA: http://www.simul8.com/products/visa.htm
- WEB-HIPRE: http://www.hipre.hut.fi/
- WINPRE: http://www.sal.hut.fi/Downloadables/winpre.html .

Main MCDA Software Tools

General Multiple Objective Decision Making

- In models with multiple objectives, decision criteria are expressed in the form of mathematical objective functions that must be optimized. These models may involve linear or nonlinear objective functions and continuous or discrete variables.
  - ADBASE (Steuer, 2000)
  - TEC ADVISOR: http://www.technologyevaluation.com/products/decision-support-systems/
  - FGM (Feasible Goals Method): http://www.ccas.ru/mmes/mmeda/fgm.htm
  - GUIMOO: http://guimoo.gforge.inria.fr/
  - KAPPALAB: http://cran.r-project.org/web/packages/kappalab/

Main MCDA Software Tools

General Multiple Objective Decision Making

- MULTIGEN (Mirrazavi et al., 2003)
- MULTISTAT: http://www.multistat.com/
- PARADISEO: http://paradiseo.gforge.inria.fr/
- SOLVEX: http://www.ccas.ru/pma/product.htm
- TRIMAP (Clímaco and Antunes, 1989)
- TOMMIX (Antunes et al., 1992)
- WWW-NIMBUS: http://nimbus.mit.jyu.fi/ .

Main MCDA Software Tools

Multiple Criteria Sorting Problems

- The software in this category classifies the alternatives into predefined groups or classes.
  - ELECTRE TRI: http://www.lamsade.dauphine.fr/english/software.html#TRI
  - IRIS: http://www4.fe.uc.pt/lmcdias/iris.htm
  - PREFDIS (Zopounidis and Doumpos, 2000)
  - TOMASO: http://www.inescc.pt/~ewgmcda/SW_TOMASO.pdf .

Main MCDA Software Tools

Specific Applications Software

- In this category we cite some applications developed for specific areas.
  - AUTOMAN: http://tgtoil.com/en/automan_software/
  - BANKADVISOR (Mareschal and Brans, 1991)
  - CASTART (Gandibleux, 1999)
  - DIDASN++ (Wierzbicki and Granat, 1999)
  - ESY (Papamichail and French, 2000)
  - FINCLAS (Zopounidis and Doumpos, 1998)
  - INVEX (Vrane et al., 1996)
  - LPA VISIRULE: http://www.lpa.co.uk/

Main MCDA Software Tools

Specific Applications Software

- MARKET EXPERT (Matsatsinis and Syskos, 1999)
- MEDICS (Du Bois et al., 1989)
- MOIRA: http://user.tninet.se/~fde729o/MOIRA/Software.htm
- PROAFTN: http://iit-iti.nrc-cnrc.gc.ca/projects-projets/proaftn-meth-proaftn_e.html
- SANEX: http://www.iees.ch/EcoEng001/EcoEng001_R3.html
- SKILLS EVALUATOR: http://www.astrolavos.tuc.gr/contents/skills_evaluator.htm
- TELOS (Grigoroudis et al., 2000)
- WATER QUALITY PLANNING DSS: http://www.ccas.ru/mmes/mmeda/papers/vodhoz.htm .

Main MCDA Software Tools

Group Decisions Support

- The software in this category serves primarily to deal with problems where there is more than one decision-maker.
  - AGAP (Costa et al., 2003)
  - ARGOS (Colson, 2000)
  - ATHENA: http://www.athenasoft.org/sub/software.htm
  - GMCR (Hipel et al., 1997)
  - HIPRIORITY: http://www.quartzstar.com/
  - MEDIATOR: http://www.matchware.com/en/products/mediator/
  - OPINIONS-ONLINE: http://www.opinions.hut.fi/index2.html
  - SCDAS (Lewandowski, 1989)
  - WINGDSS: http://www.oplab.sztaki.hu/wingdss_en.htm .

Conclusions and Future Research

- Several authors maintain that decision-making is a vast and difficult problem.
- There is no single model that fits all circumstances.
- Decision analysis presents rational methods to select an alternative (the best) or a group of alternatives from among a set of possible ones.
- Most of the software referenced in this presentation have characteristics of more than one category. We chose to put them in the category where the most prominent feature resides.
- Some of the tools presented are not available on the open market; others have a web page where one can download a free version for testing the product and learn of purchasing information.

Conclusions and Future Research

- When purchasing MCDA software, one needs not only to be concerned with the technology (i.e., hardware and software), but also with the role of the decision maker in the process and the ease of use of the tool.
- This review of software analysis tools for multicriteria decision making is far from complete since new tools appear every day.
- After this literature review, a decision tool is being developed to help in the selection process of the right decision software available, among the ones studied, depending on the goals of the decision maker.

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