

Decision Analysis Part 4: Multi-Attribute Models

Marko Bolanec

Motivation for Multi-Attribute Modeling

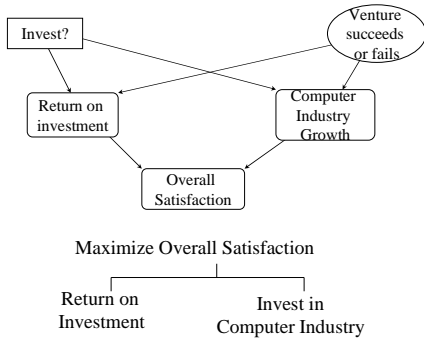
So far we have considered single-objective models, but most of real-life decisions are multiple-objective: e.g.: price + performance (conflicting)

Influence diagrams facilitate multi-objective modeling to some degree. However, more is needed in terms of model development and analysis of decisions. Thus, specialised models and software.

Multi-attribute modeling is very useful and practical.

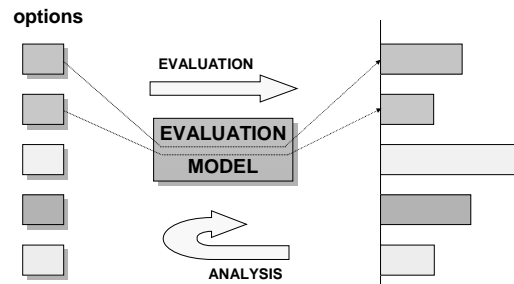
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ID's and Multiple Objectives



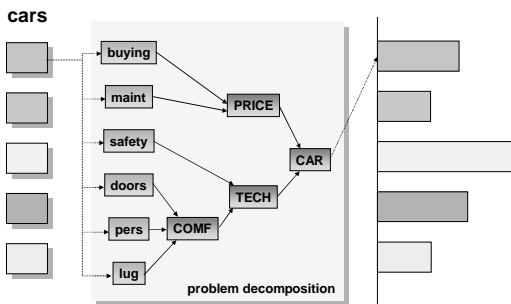
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Evaluation Models



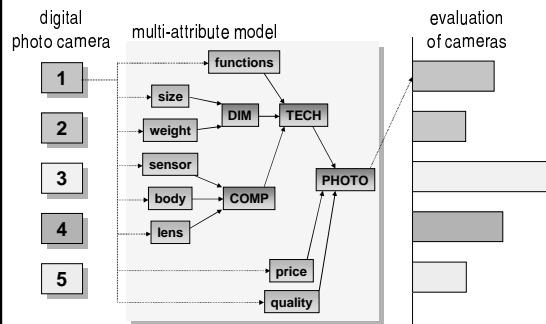
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Multi-Attribute Models



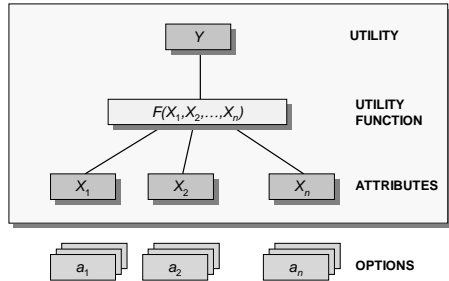
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Multi-Attribute Models



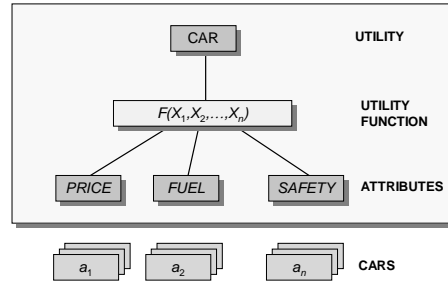
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Multi-Attribute Model Structure



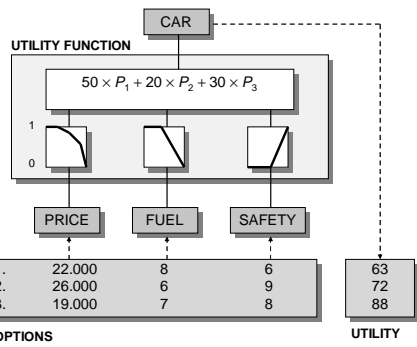
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Multi-Attribute Model for Car Selection



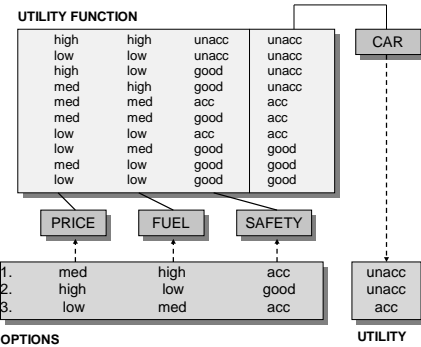
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Quantitative Multi-Attribute Model for Car Selection



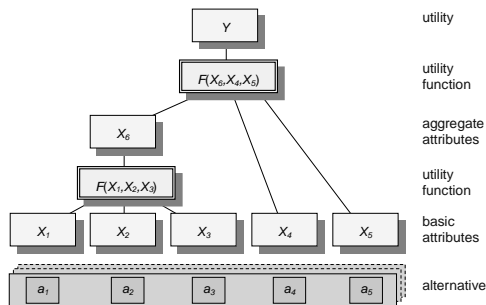
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Qualitative Multi-Attribute Model for Car Selection



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Hierarchical Multi-Attribute Model



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Questions

- Have you ever encountered a:
 - multi-objective decision problem?
 - multi-attribute model?
 When, where, for what kind of problems?
- Compare multi-attribute models with:
 - decision trees
 - influence diagrams
- Suggest types of decision problems suitable for the application of multi-attribute models

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Multi-Attribute Modelling: *Why?*

- Systematic, structured approach (to difficult real-life problems)
- Model development:
 - problem decomposition into smaller, less-complex subproblems
 - requires understanding and careful elaboration of the problem
 - facilitates and motivates communication and knowledge interchange
- Evaluation:
 - selection of a single option
 - option ranking
- Analysis:
 - “what-if” analysis
 - sensitivity analysis
 - explanation:
 - *how?* (evaluation procedure)
 - *why?* (selective explanation of advantages/disadvantages)
 - option generation
- Contributes to better decisions:
 - understanding, justification, explanation, documentation

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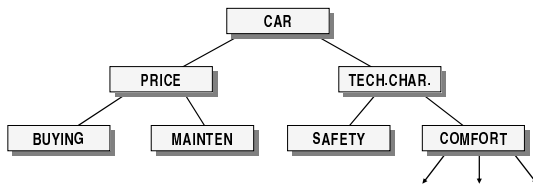
Multi-Attribute Modelling: *How?*

0. Problem identification
 1. Tree (or hierarchy) of attributes
 2. Utility functions
 3. Evaluation and analysis of alternatives
- 4+ Implementation

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1. Tree of Attributes

Decomposition of the problem to to sub-problems (“*Divide and Conquer!*”)

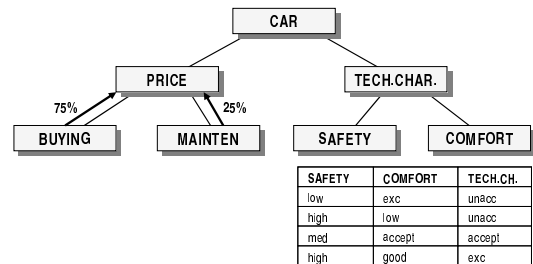


The most difficult stage!

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2. Utility Functions (Aggregation)

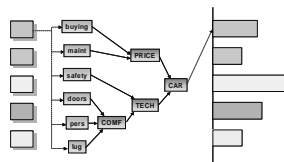
Aggregation: bottom-up aggregation of attributes' values



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3. Evaluation and Analysis

EVALUATION

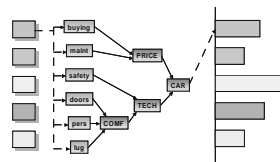


- direction: bottom-up (terminal ⇒ root attributes)
- result: each option evaluated
- inaccurate/uncertain data?

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3. Evaluation and Analysis

ANALYSIS



- interactive inspection
- “what-if” analysis
- sensitivity analysis
- explanation

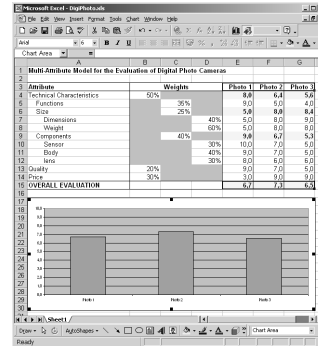
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MADM Tools

1. "Paper and Pencil" (Abacon)
2. Spreadsheets and mathematical modelling software (MS Excel)
3. Specialized MADM software

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Spreadsheet Modelling

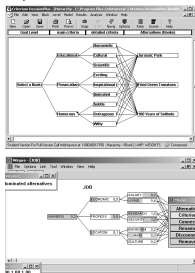
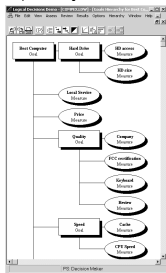


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Specialized Software (1/4)

Logical Decisions
<http://www.logicaldecisions.com/>

Criterion DecisionPlus
<http://www.infoharvest.com/>

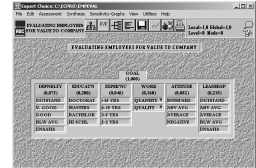


WinPre
<http://www.hut.fi/Units/SAL/Downloadables/winpre.html>

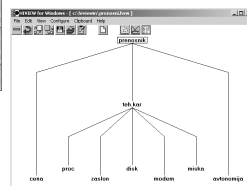
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Specialized Software (2/4)

Expert Choice
<http://www.expertchoice.com/>



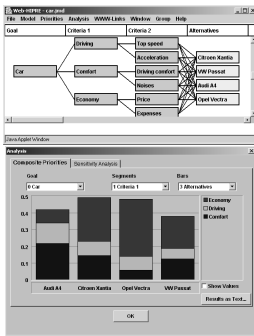
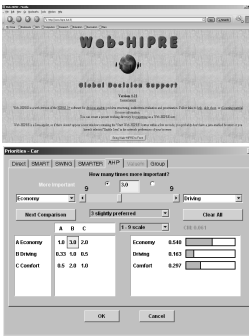
HiView
<http://www.catalyze.co.uk/products/hiview>



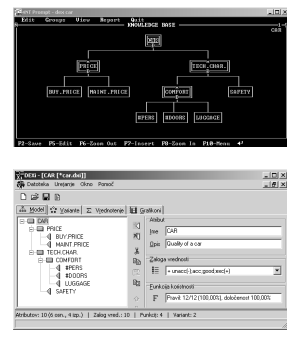
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Specialized Software (3/4)

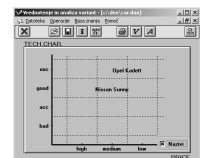
Web-HIPRE
<http://www.hipre.hut.fi/>



Specialized Software (4/4)



DEX



Vredna

DEXi

<http://kt.ijs.si/MarkoBohanec/dexi.html>

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Exercise

You would like to buy a new laptop computer for your own purposes (study, internet, fun, ...).

Suggest a suitable set of attributes and create a tree of attributes.

Consider the guidelines presented on the next two slides.

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Developing Attribute Structure

Three basic strategies:

- *Top-Down*: Start with the overall evaluation (target objective), decompose it to sub-goals.
- *Bottom-Up*: Start with desirable characteristics, sub-goals. Group them into connected, meaningful sub-trees.
- *Middle-Out*: Combining the two above. Iteratively decompose (refine) and group (generalise) attributes.

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Developing Attribute Structure

Desirable features of attributes and their structure:

- *Completeness*: Do not overlook important attributes
- *Relevance (non-redundancy)*: Use only relevant attributes, omit redundant attributes
- *Minimality*: Use a minimal number of attributes
- *Orthogonality*: Basic attributes should be independent of each other
- *Operativity*: Basic attributes should be easy to assess or measure
- *Comprehensibility*: Create meaningful sub-trees of inter-related attributes

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