

DEXi: Methodology and Software

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DEX: Expert System Shell for Multi-Attribute Decision Making

1987–1995, DOS



DEXi: “DEX for Education” Computer Program for Multi-Attribute Decision Making

1999→, Windows

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DEX

DEX: An Expert System Shell for MADM (1989)

Based on:

- multi-attribute decision making
- expert systems
- machine learning
- fuzzy logic

Qualitative decision modelling:

- qualitative attributes
- decision rules

SAFETY	COMFORT	TECH
low	low	unacc
low	high	unacc
med	low	unacc
med	med	acc
med	high	good
high	low	unacc
high	high	exc

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DEX and DEXi: Background

1. Multi-Attribute Decision Making

- modelling using criteria and utility functions
- problem decomposition and structuring
- option evaluation and analysis

2. Expert Systems

- qualitative (symbolic) variables
- "if-then" decision rules
- decision model = knowledge base
- emphasis on the explanation of results (DEX)

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DEXi

Computer Program for
Multi-Attribute Decision Making

A simple computer program for MADM that facilitates:

- Creation and editing of
 - model structure (tree of attributes)
 - value scales of attributes
 - decision rules (incl. using weights)
 - options and their descriptions (data)
- Evaluation of options (can handle missing values)
- Presentation of evaluation results with:
 - tables
 - charts
- "What-if" analysis
- Preparing a report

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Stages of MADM (with DEXi)

0. Problem Identification

- a. problem formulation
- b. formation of a decision-making group
- c. selection of decision-support methodology

1. Identification of Attributes

- a. unstructured list of attributes
- b. *hierarchy (tree) of attributes*
- c. measurement scales

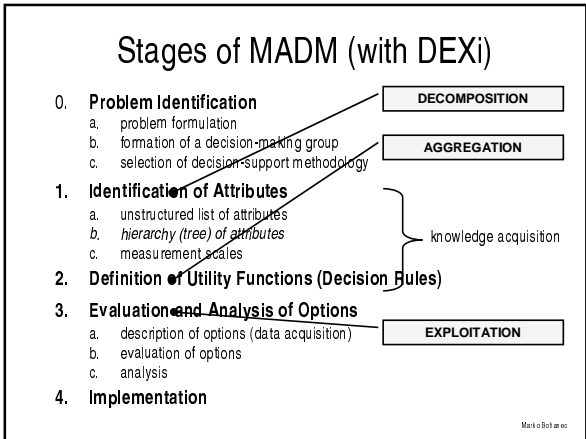
2. Definition of Utility Functions (Decision Rules)

3. Evaluation and Analysis of Options

- a. description of options (data acquisition)
- b. evaluation of options
- c. analysis

4. Implementation

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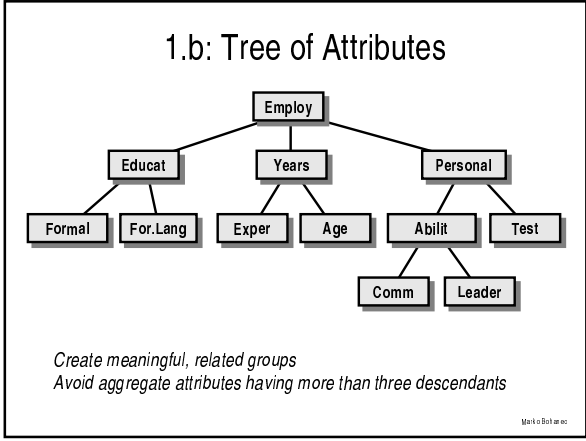
1.a: Unstructured List of Attributes

Problem in Personnel Management:
Select of a Candidate for a Job (e.g., a project manager)

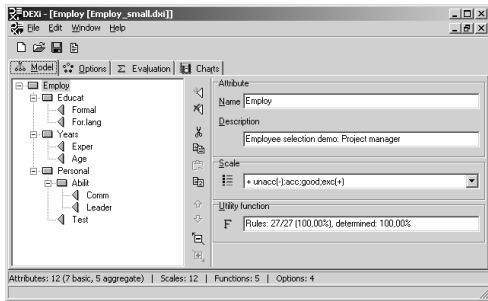
<ul style="list-style-type: none"> • education • age • experience • references • knowledge • work approach • ability to work in a group 	<ul style="list-style-type: none"> • leadership • organizational abilities • loyalty • intelligence • communicativity • character • health • ...
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Do not overlook important attributes!

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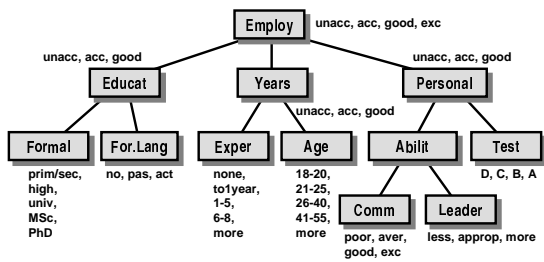


1.b: Tree of Attributes



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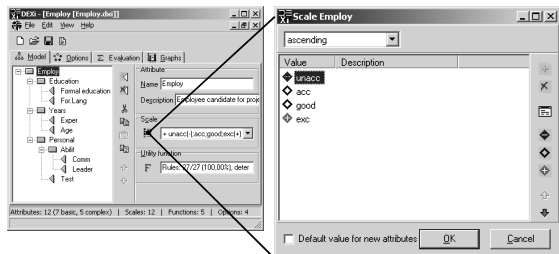
1.c: Scales



Scales are discrete, typically ordered from bad to good
 Values should distinguish between importantly different characteristics
 Their number should gradually increase from bottom to the root

Mark A. Behr et al.

1.c: Scales



Mark A. Behr et al.

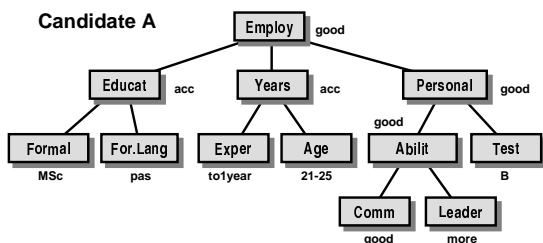
3.a: Description of Options

Option	A	B	C	D
Formal	MSc	PhD	PhD	PhD
For.Lang	pas	act	act	act
Exper	to1year	more	6-10	6-10
Age	21-25	26-40	26-40	26-40
Comm	good	aver	good	exc
Leader	more	less	less	more
Test	B	B	C	A

3.bc: Evaluation and Analysis of Options

1. Evaluation
 - proceeds from bottom (basic attributes) to the root
 - result: *qualitative* evaluation of each option
 - handles *missing* (DEXi) or *imprecise* (DEX) option values
2. Analysis
 - interactive *inspection* of results
 - *what-if* analysis
 - analyses:
 - *compare options*
 - “±1” analysis
 - selective explanation
 - *reports*
 - *charts*

3.b: Evaluation of an Option

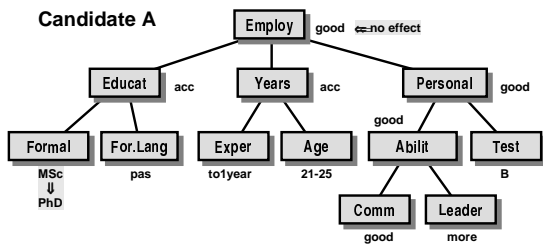


3.b: Evaluation of Options

Option	A	B	C	D
Employ	good	unacc	unacc	exc
Educat	acc	good	good	good
Formal	MSc	PhD	PhD	PhD
For.Lang	pas	act	act	act
Years	acc	good	good	good
Exper	to1year	more	6-10	6-10
Age	21-25	26-40	26-40	26-40
Personal	good	unacc	unacc	good
Abilit	good	unacc	unacc	good
Comm	good	exc	good	exc
Leader	more	less	less	more
Test	B	B	C	A

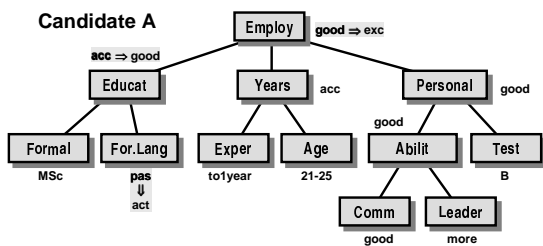
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3.c: What-If Analysis



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3.c: What-If Analysis



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3.c: What-If Analysis

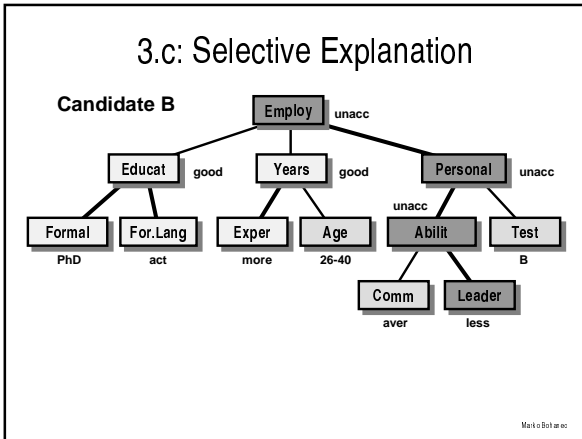
Option	A	A	B	C	D
Employ	good	exc	unacc	unacc	exc
Educat	acc	good	good	good	good
Formal	MSc	MSc	PhD	PhD	PhD
For.lang	pas	act	act	act	act
Years	acc	acc	good	good	good
Exper	toyear	toyear	more	6-10	6-10
Age	21-25	21-25	26-40	26-40	26-40
Personal	good	good	unacc	unacc	good
Abilit	good	good	unacc	unacc	good
Comm	good	good	aver	good	exc
Leader	more	more	less	less	more
Test	B	B	B	C	A

3.c: “± 1” Analysis

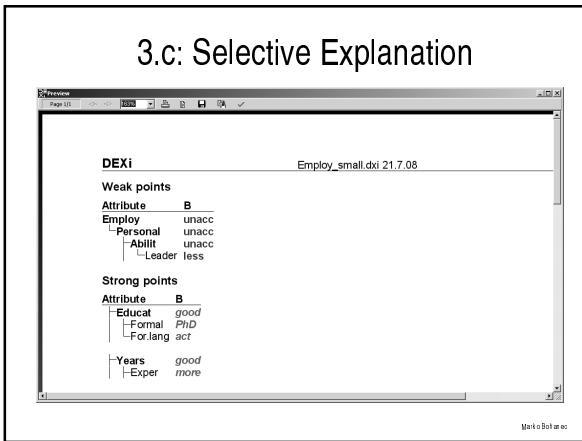
3.c: Compare options

Attribute	B	A	C	D
Employ	unacc	good		exc
Educat	good	acc		
Formal	PhD	MSc		
For.lang	act	pas		
Years	good	acc		
Exper	more	toyear	6-10	6-10
Age	26-40	21-25		
Personal	unacc	good		good
Abilit	unacc	good		good
Comm	aver	good	good	exc
Leader	less	more		more
Test	B		C	A

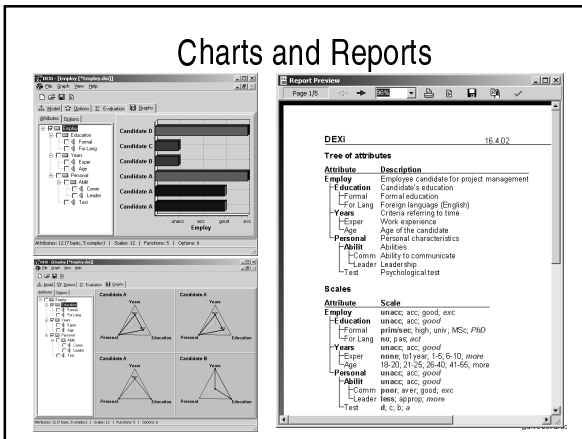
3.c: Selective Explanation



3.c: Selective Explanation



Charts and Reports



DEX and DEXi: Experience

- Wide applicability to various application areas
 - Usually, solutions are specific (non-general)
- 1. Model development time**
 - heavily problem-dependent: from hours to months
 - typical: 2 to 15 days
 - 2. The most difficult stage**
 - designing the tree of attributes
 - 3. Appropriate decision problems**
 - many attributes (> 15)
 - many options (> 10)
 - prevailing qualitative decision-making, judgment
 - inaccurate or missing data
 - group decision making (communication and explanation)
 - sufficient resources available (expertise, time)

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DEX in DEXi: Future

- Combined qualitative and quantitative models
- Extensions:
 - Data Mining (e.g. machine learning of models by HINT)
 - Data Bases, Data Warehouses, OLAP
- Software:
 - "Dex Machine": Low-level OO library for QQ models
 - Various types and levels of GUI

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DEX and DEXi: Summary

- 1. Combination of**
multi-attribute decision making and expert systems
- 2. Characteristics:**
 - qualitative (symbolic) decision making
 - explanation and analysis
 - active support in the acquisition of decision rules
- 3. Applicability:**
 - for complex real-world problems
 - over 50 real-life applications

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Exercise

1. Take one of the already defined "empty" models shown on the next slide
2. Define all utility functions (decision rules) in that model
3. Define and describe a few (about 4) options
4. Evaluate and analyse the options
5. Extend the model:
 - add and/or refine a few attributes (including their scales and rules)
 - repeat the steps 2, and 4.
6. Prepare and print out (or save) a report

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Models

Portable Computer

Attribute	Description
PORTABLE	Portable computer
- COMMERCIAL	
- PRICE	[in Euro]
- TECHNICAL	
- INTERNAL	
- PROCESSOR	
- MEMORY	
- DISK	
- EXTERNAL	
- MONITOR	
- KEYBOARD	
- AUTONOMY	

Programmer's Performance

Attribute	Description
PROGRAMMER	Programmer's Performance
- KNOWLEDGE	Knowledge of the Programmer
- EXPER	Working Experience
- SPECIAL	Specialized Knowledge
- WORK	Quality of Programmer's Work
- QUALITY	Quality of the Results
- EFFECTIVE	Work Effectiveness: Are the results delivered in time?
- APPROACH	Working Approach
- TEAM	Attitude to Team Work
- PERSONAL	Personal Characteristics
- INITIATIVE	Self-Initiativeness
- CREATIVE	Creativity

Car Selection

Attribute	Description
CAR	Quality of a car
- PRICE	Price of a car
- BUY PRICE	Buying price
- MAINT PRICE	Maintenance price
- TECH CHAR.	Technical characteristics
- COMFORT	Comfort
- PERS	Maximum number of passengers
- DOORS	Number of doors
- LUGGAGE	Size of the luggage boot
- SAFETY	Car's safety

Performance Evaluation of Companies

Attribute	Description
ENTERP	Performance evaluation of enterprises
- FINANC	
- RETURN	
- PROFIT	
- PROF-AB	
- LIQUID	
- ECONOMIC	
- PRODUCT	
- CAPACITY	

Also available: **Employ**

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