

## DEXi: Methodology and Software

Marko Boharac

## 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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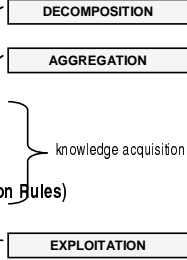
## Stages of MADM (with DEXi)

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

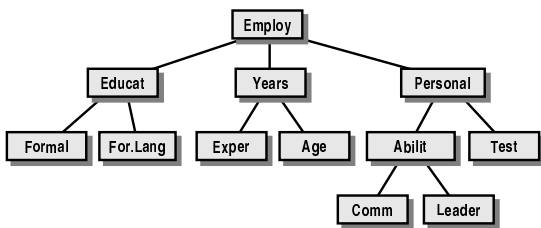
**Problem** in Personnel Management:  
Select of a Candidate for a Job (e.g., a project manager)

- education
- age
- experience
- references
- knowledge
- work approach
- ability to work in a group
- leadership
- organizational abilities
- loyalty
- intelligence
- communicativity
- character
- health
- ...

*Do not overlook important attributes!*

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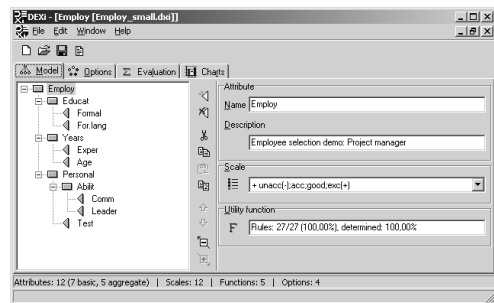
## 1.b: Tree of Attributes



*Create meaningful, related groups  
Avoid aggregate attributes having more than three descendants*

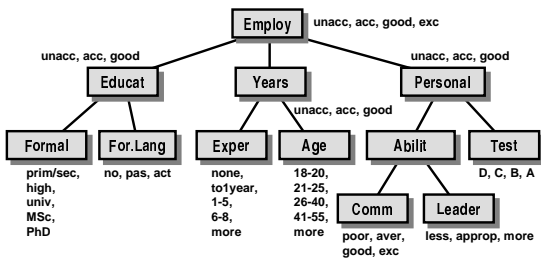
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## 1.b: Tree of Attributes



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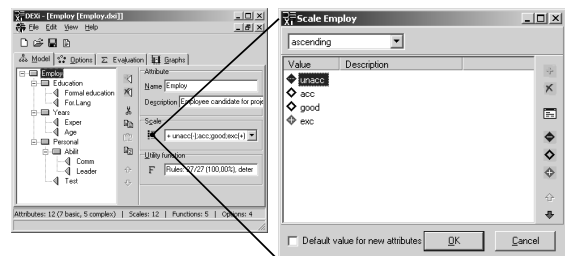
## 1.c: Scales



*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*

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## 1.c: Scales

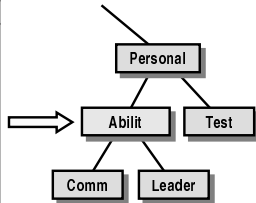


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## 2: Decision rules

Utility Functions, Bottom-Up Aggregation

Comm	Leader	Ablitt
poor	less	unacc
poor	approp	unacc
poor	more	unacc
aver	less	unacc
aver	approp	acc
aver	more	acc
good	less	unacc
good	approp	acc
good	more	good
exc	less	unacc
exc	approp	good
exc	more	good

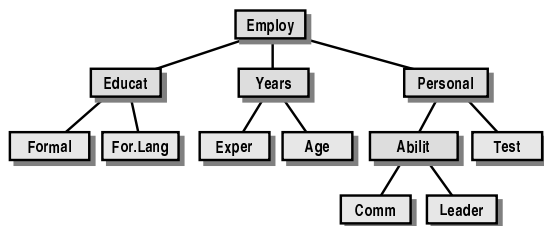


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## 2: Decision rules

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## 3.a: Description of Options



Candidate	Formal	For.Lang	Exper	Age	Comm	Leader	Test
A	MSc	pas	to1year	21-25	good	more	B
B	PhD	act	more	26-40	aver	less	B

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## 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

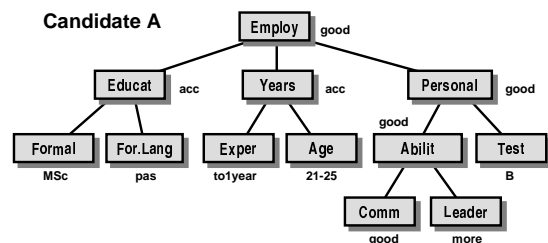
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## 3.bc: Evaluation and Analysis of Options

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

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## 3.b: Evaluation of an Option



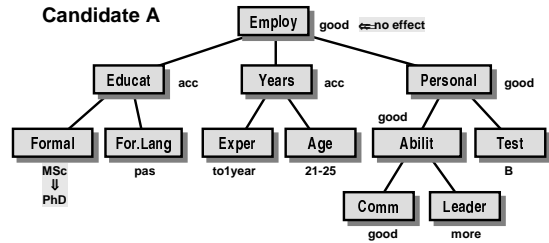
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### 3.b: Evaluation of Options

Option	A	B	C	D
Employ	good	unacc	unacc	exc
Educ	acc	good	good	good
Formal	MSc	PhD	PhD	PhD
For.Lang	pas	act	act	act
Years	acc	good	good	good
Exper	to/year	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	aver	good	exc
Leader	more	less	more	more
Test	B	B	C	A

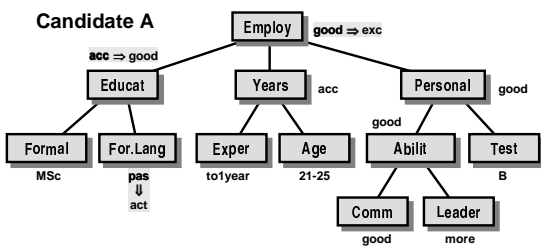
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### 3.c: What-If Analysis



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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
Educ	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	to/year	to/year	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

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### 3.c: "±1" Analysis

Attribute	-1	A	+1
Employ		good	
Formal		MSc	
For.Lang	unacc	pas	exc
Exper	unacc	to/year	
Age	unacc	21-25	
Comm	acc	good	
Leader	acc	more	
Test	acc	B	

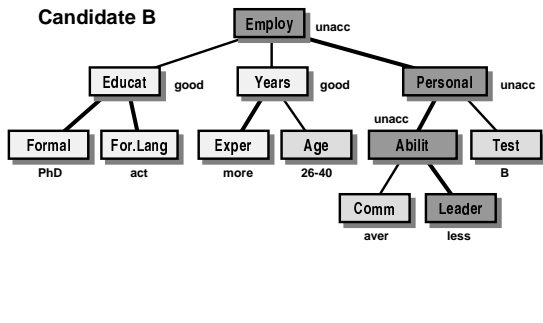
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### 3.c: Compare options

Attribute	B	A	C	D
Employ	unacc	good		exc
Educ	good	acc		
Formal	PhD	MSc		
For.Lang	act	pas		
Years	good	acc		
Exper	more	to/year	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

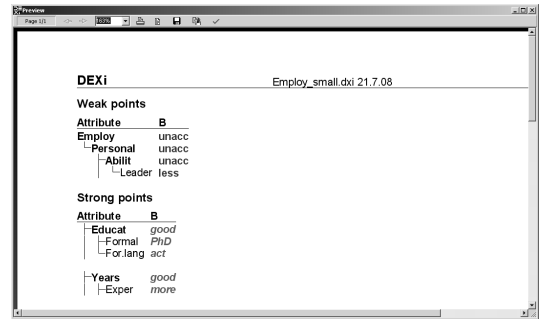
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### 3.c: Selective Explanation



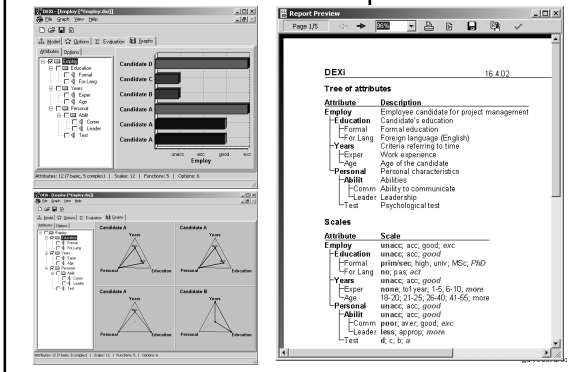
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### 3.c: Selective Explanation



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### Charts and Reports



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### 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 ]
-IMAGE	
-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
-EQUALITY	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 Initiative
-CREATIVE	Creativity

### Car Selection

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

### Performance Evaluation of Companies

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

Also available: Employ

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