

Complex decision problems

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Fundamentals of decision theory

- **Problem Owner, Decision-maker**
- **Decision task = problem**
- **Tools**
- **Decision logic**

Simple decision tools

- **Decision table**
- **Decision tree**

Software tool groups for decision problems

MSS - Management Support System

- **ES - Expert System pl. MYCIN, DENDRAL**
- **DSS/GDSS - (Group) Decision Support System**
- **EIS - Executive Information System**
- **ESS - Executive Support System**
- **Others: e.g. Artificial Intelligence, simulation**

Decision logics

- **ALLOCATION** type :
 - in fix time
 - race condition
 - limited resource
 - OUTPUT: distribution
- **CREDIT** type:
 - unlimited time
 - unlimited piece
 - requirements
 - no race condition
 - OUTPUT: yes / no
- **SELECTION** type
 - in fix time
 - race condition
 - viewpoint/respect system
 - choosing 1 from more alternatives
 - OUTPUT: winner

Circumstances of decisions

- **Decision rules:** All rules of the circumstances
E.g. public procurement procedure
- **Influencing factors**

Decision types

- Decisions under certainty
- Decisions with risk
- Decisions under uncertainty

	Q1	Q2	Q3
B	6.1	6.2	6.3
R	6	6.5	7
S	3	6	9
E	0	6	12

Decision theory paradoxes

- Allais paradox
- St. Petersburg paradox

Decision theory paradoxes

- Allais paradox

- A: 1 M\$

- B: 10% 5 M\$

89% 1 M\$

1% 0

Decision theory paradoxes

- Allais paradox

- A: 1 M\$

- C: 11% 1 M\$

- 89% 0

- B: 10% 5 M\$

- D: 10% 5 M\$

- 89% 1 M\$

- 90% 0

- 1% 0

Decision theory paradoxes

- St. Petersburg paradox

	Prize
1.	2
2.	4
3.	8
...	
n	2^n

Decision problems in many respects

Multi-criteria Decision Analysis (MCDA)
Multi-criteria Decision Making (MCDM)

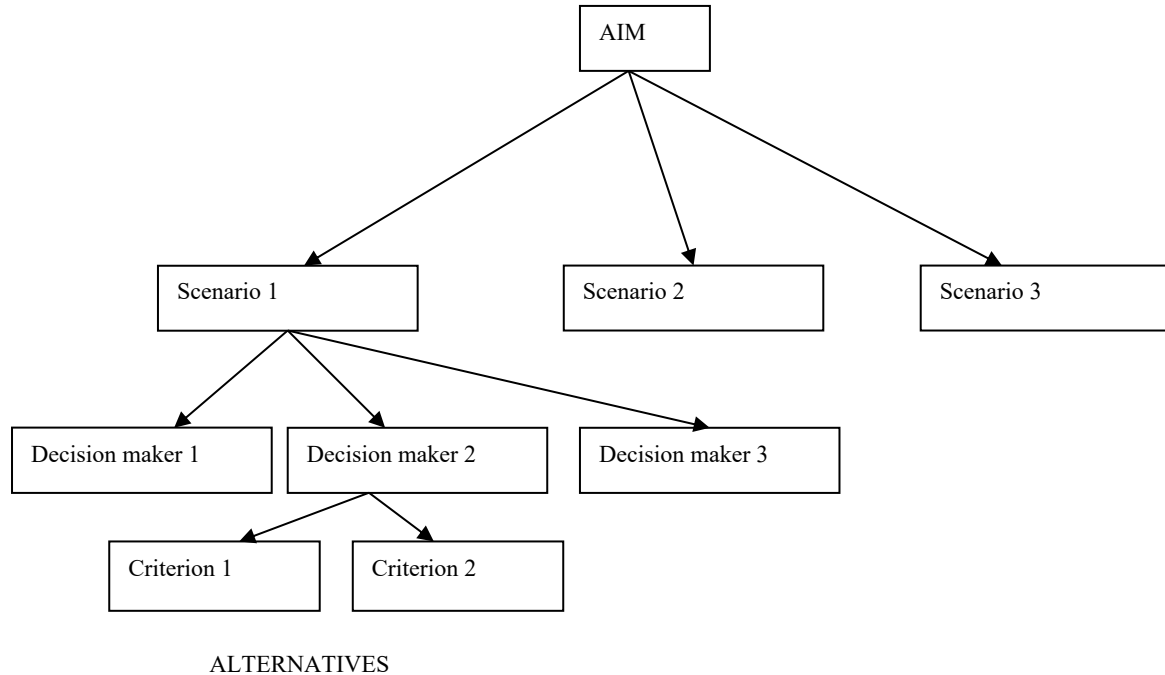
Multi-criteria Decision Models

- **Analytic Hierarchy Process (AHP)**
- **Analytic Network Process (ANP)**
- **ELECTRE (Outranking)**
- **Multi-Attribute Utility Theory (MAUT)**

AHP

- Method is based on decomposition and synthesis.
- **Pair-wise comparison**
- Quantitative and qualitative variables.
- E.g.: Expert Choice software.

Hierarchical structure of AHP method



AHP procedure

- Let us see $C_1, \dots, C_m$ criteria in a level of the hierarchy
- The weights corresponding to criteria: $\omega_1, \dots, \omega_m$

AHP procedure (2)

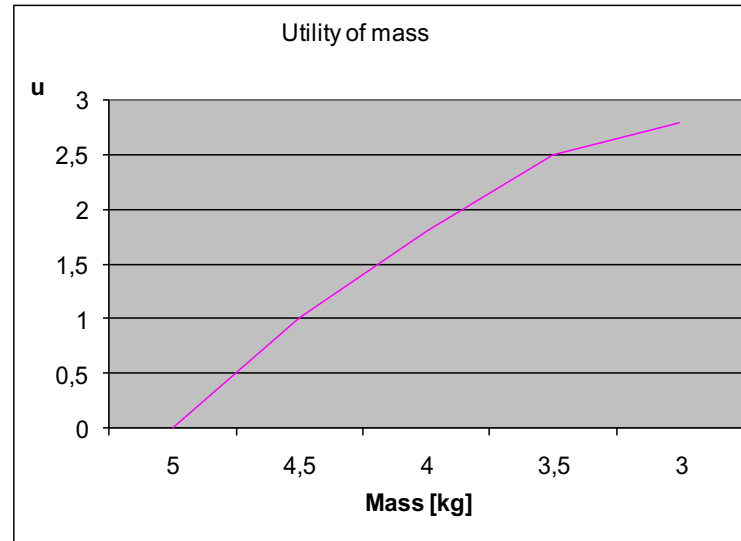
- Pair-wise comparison of criteria: how much times more important criteria C_i than criteria C_j
 - $r_{ij} = \omega_i / \omega_j$
- r_{ij} values: R matrix. In ideal case:
 - $R \cdot \omega = m \cdot \omega$
 - where $\omega = [\omega_1, \dots, \omega_m]$

AHP procedure (3)

- Property of matrix R:
 - $r_{ji} = 1 / r_{ij}$
 - and
 - $r_{ij} * r_{jk} = (\omega_i / \omega_j) * (\omega_j / \omega_k) = \omega_i / \omega_k = r_{ik}$
- In case of r_{ij} comparisons derived from decision makers: ω_i' are the estimated values of ω_i values.
 - $R' * \omega' = \lambda * \omega'$
- Solution of eigenvalue problem (linear algebra)
- Rank of R is 1, $r_{ii}=1$, consistency can be verified by the difference between m and maximal eigenvalue

MAUT (Multi-Attribute Utility Theory)

- Base on utility functions
- E.g:



MAUT

Decision procedure:

- Gathering the alternatives, declaration of viewpoints.
- Definition of utility functions.
- Determination of weights of each viewpoint.
- Valuation of all alternatives in each viewpoint.
- Summarization of weighted values.
- Analysis after the assessment, and proposal.

Group decision support methods

- Brain Storming
- Delphi methods
- Nominal Group Technique (NGT)
- Other Creative Problem Solving Processes
- Synectics
- Decision conference