
ENTER HERE
TODAY'S SEMINAR:
THE ART OF DECISION MAKING
ENTER HERE
UH, OH...

An overview of *Decision Analysis*

Denis Bouyssou

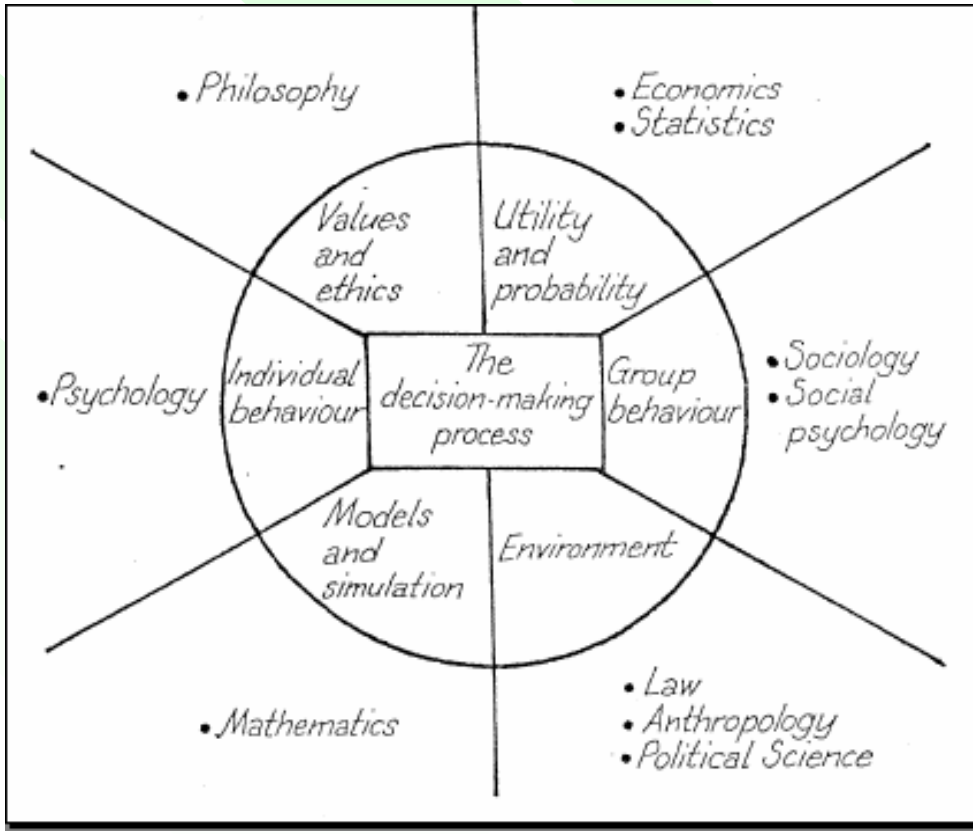
CNRS — LAMSADE

Aims of the lecture

- "Decision"
  - Many different types
  - Many different techniques for "decision aiding" (decision analysis)
- Give a *general framework* for thinking about decisions
- Put the various *decision analysis techniques* in perspective

Decision

- Philosophy
- Economics
- Psychology
- Sociology
- Political Science
- Computer Science
- Operational Research
- Biology?
- Theology?



Outline

- Classical view on decision
- Another view
- What can be expected?
- What should we take care of?
- What are the main types of models?

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Decision?

- **Classical view: Catastrophe, Bifurcation**
  - ➪ **Conscious individual freely choosing between several courses of action (Reflection then commitment of resources and responsibility)**
- **Culturally biased view + Philosophic difficulties**
  - ➪ **Serious… but you are not interested in anthropology or philosophy**
- **Practical difficulties**
  - ➪ **Can we observe such decisions?**
  - ➪ **Empirical question (Organizational Behavior)**

France (CEOs)

- ⇨ 15 % transports
- ⇨ 5 % visits
- ⇨ 5 % individuals interviews
- ⇨ 30 % internal meetings
- ⇨ 10 % external meetings
- ⇨ 10 % meals
- ⇨ 15 % telephone
- ⇨ 5 % reading / writing mail
- ⇨ 2 % writing
- ⇨ 2 % reading
- ⇨ 1 % solitary reflection (6 min./day)
- ⇨ 0 % computers

Transport 20 %

Meetings 55 %

Individual work 25

UK managers

- 160 managers in the UK
  - ➪ Only 1 period every two days in which they work continuously on the same subject for 30 minutes
  - ➪ Only 1 verbal contact in 398 deals with organization / planning
  - ➪ On average 583 different activities within 8 hours
    - 0,82 min (50 sec.) per activity

Mintzberg's Studies of Managers

- Myth #1: The manager is a reflective systematic planner
  - **Fact**: Study after study shows managers work at an unrelenting pace, that their activities are characterized by *brevity, variety, and discontinuity*, they are strongly oriented toward action, and dislike reflective activities
- Myth #2: The effective manager has no regular duties to perform
  - **Fact**: Managerial work involves performing a number of regular duties, including ritual and ceremony, negotiations, and processing of soft information that links the organization with its environment

Mintzberg's Studies of Managers

- Myth #3: The senior manager needs aggregated information, which a formal management information system best provides
  - **Fact**: Managers strongly favor *verbal media*, telephone calls, and meetings over documents
- Myth #4: Management is, or at least is quickly becoming, a science and a profession.
  - **Fact**: The managers' programs (to schedule time, process information, make decisions, and so on) remain locked deep inside their brains.

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Decision

- ***Provisional definition*** **[R. Howard]: Decision making is what you do when you do not know what to do**
  - ➪ **Criteria: Anxiety, Fear, Hyper-vigilance**
  - ➪ **Obvious symptoms**
    - **Scribbling on a sheet of paper / worksheet**
    - **Multiplication of meetings**
    - **Procrastination**
    - **Depression / Enthusiasm**
  - ➪ **Origin of anxiety**
    - **High / complex stakes**
    - **Uncertainty / Time horizon / Multiples objectives**

Three classical attitudes

- **Recourse to an *omen* (tell me what is good)**
  - ⇨ **Intuition / Charismatic leader / Expert / Authority**
- **Perform *ritual sacrifices* (tell me who is to blame)**
  - ⇨ **René Girard: *Things hidden since the foundation of the world*, *The scapegoat***
- **Buy a *consulting study* (tell me what to do)**

Let someone else carry your anxiety

Decision analytic tools = Tools for managing anxiety (without letting someone else carry it)

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What Decision Analysis *is not* (1/2)

- **A general method for taking "good decisions"**

  Example

  - ⇨**Choice 1: [Heads] 1000 € [Tails] 0 €**
  - ⇨**Choice 2: [Heads Heads] 5000 € [Otherwise] 0 €**

  Example

  - ⇨**Choice of new job, medical decision, etc.**

- **What is a "good decision"?**
  - ⇨**Good for whom, according to what criteria, at which moment in time?**
- **Good *decision process vs.* good *decision***
  - ⇨**Japanese shoemaker**

What Decision Analysis *is not* (2/2)

- A description of how "wise people" decide
  - ⇨ Are wise people always right?
    - Doctors / Politicians
    - Nuclear Industry vs. Road safety
      - ⇨ 5 000 000 vs. 140 000 (USD 1978)
  - ⇨ How do you recognize "wise people"?
    - Luck vs. Wisdom
    - Gurus and markets
- What can we do then?

Example: rolling a dice

	1	2	3	4	5	6
a	0	100	200	300	400	500
b	100	200	300	400	500	0

	1	2	3	4	5	6
a	10	110	210	310	410	510
b	100	200	300	400	500	0

- **Natural (intuitive) but deceptive reasoning**

Decision Analysis

- **Definition (B. Roy): "…consists in trying to provide *elements of answer* to questions raised by actors involved in a *decision process* using a *model*…"**
  - ⇨ **decision process**
  - ⇨ **elements of answer**
  - ⇨ **model**

Decision Process

- Time
- Multiple actors
- Organization
  - ⇨ links with other processes
  - ⇨ power
- Milestones vs. final result
  - ⇨ alternatives created / rejected
  - ⇨ fragments of decisions
  - ⇨ feedback

Decision Making and Decision Processes

- Decision Making ≠ "solving" a well-defined problem
- Intervention in a decision process
  - imagine compromises
  - communicate
  - coordinate
  - control
  - motivate
  - conduct change
- Final choice
  - only part of the job
- Strategy of intervention
  - Many different (good) ways to provide decision-aid

Several uses of Decision Analysis

- ***Ex ante*** **use**
  - ➪ **trying to reach a conclusion**
- ***Ex post*** **use**
  - ➪ **insurance policy**
  - ➪ **convince others**
  - ➪ **kill another project**
  - ➪ **delay the decision**
  - ➪ **...**

Elements of answer

- **No mention is made of:**
  - ⇨ **Optimal solutions**

  or even
  - ⇨ **Good decisions**
- **Consistent with our view on decision…**
- **…but raises the question of judging the quality of decision analysis**

Models

- **Variety of models**
  - ⇨ **explicit or not**
  - ⇨ **formalized or non-formalized**
  - ⇨ **abstract (domain independent) or not**
- **Examples of models**
  - ⇨ **Astrology, Graphology, Psycho-analysis**
    - **the astrologer "provide *answers* to questions raised by his/her client using a *model*"**
- **Decision analysis mainly makes use of *explicit, abstract* and *formalized* models**

Formalized Models

- **Drawbacks**
  - **Complex**
  - **Opaque**
  - **Costly**
- **Advantages**
  - **Provide a *clear language* (reducing ambiguity)**
    - **communication tools**
  - **Capture the *essence* of a situation**
    - **structuration tools**
  - **Answers *what-if* questions (sensitivity, robustness)**
    - **Exploration tools**
- **Example: choosing a bottle of wine**

Possible Objections to the study of such tools

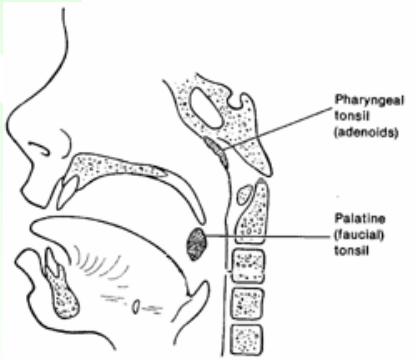
- ***We*** **do not need such tools because *we* know how to decide**
- ***Intuition*** **is often enough**
- **Let's organize a high-level *meeting* to discuss it**

I do not need it

- **OK but:**
  - **What makes you so sure?**
  - **How will you convince your Boss?**
  - **How will you avoid being a scapegoat?**

Intuition?

- Doctors
- New England Journal of Medicine
  - ⇨ Tonsillectomy
  - ⇨ Experts (3 groups) + Clinical Tableaus



389 child

- 45 % Yes
- 55 % No
  - 46 % Yes
  - 54 % No
    - 44 % Yes
    - 56 % No

Do-it-yourself example

You are confronted with the *double* decision problem:

***Problem 1*. Choose between**

- **Option A = sure gain of 1200 €**
- **Option B = gain of 5000 € with probability 25%, no gain with probability 75%**

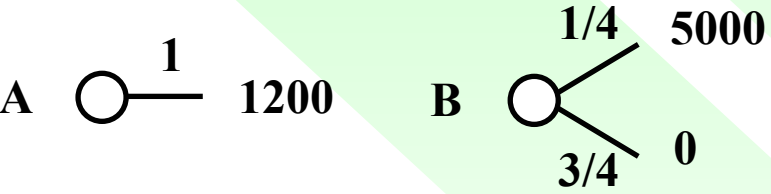
***Problem 2*. Choose between:**

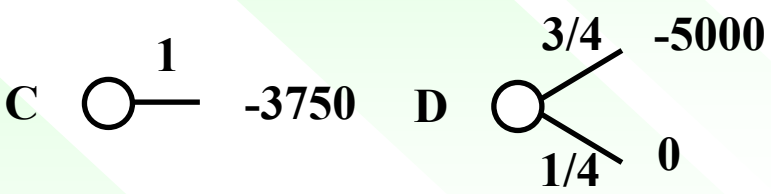
- **Option C = sure loss of 3750 €**
- **Option D = loss of 5000 € with probability 75 %, no loss with probability 25%**

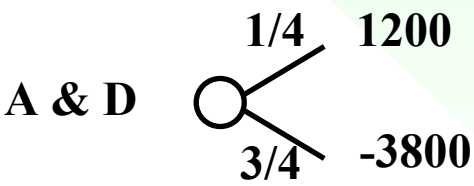
- **Make your own choices!**

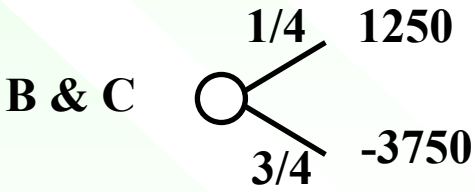
Results (D. Kahneman / A. Tversky)

- **Modal choice = A & D (73%)**







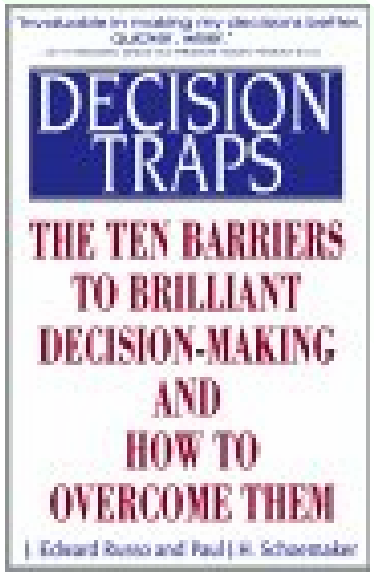


Coimbra January 200

Trap # 6

Shooting from the hip

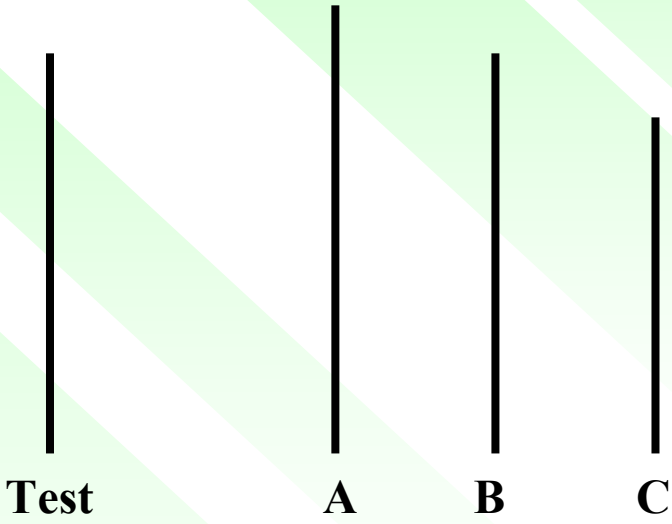
- **"Believing that you can keep straight in your head all the information you've discovered, and therefore "winging it" rather than following a systematic procedure when making the final choice"**



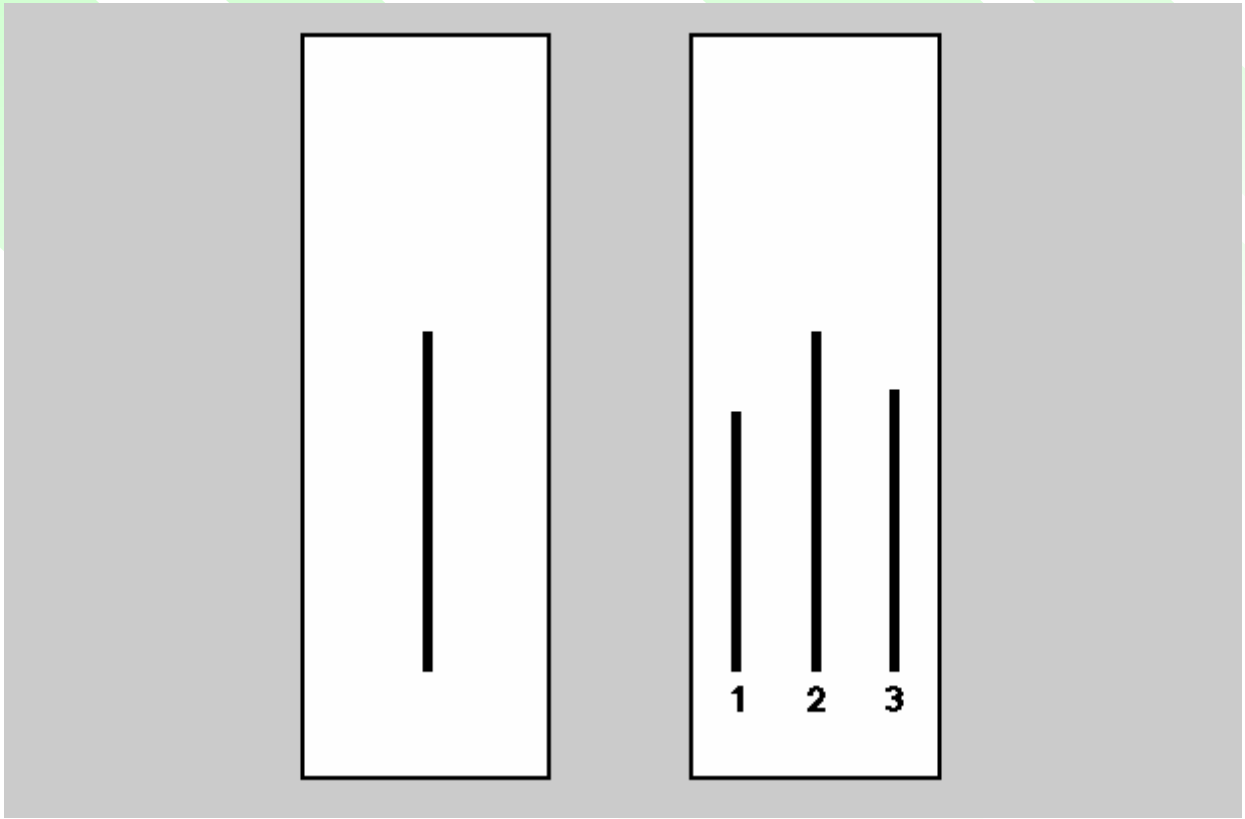
Russo & Shoemaker

Meetings?

- **Asch experiment**



- **99% correct answers**
  - ⇨ **1 person says A** — **error rate = 3%**
  - ⇨ **2 person say A** — **error rate = 13 %**
  - ⇨ **3 person say A** — **error rate = 33 %**
  - ⇨ **Bonus for correct consensus** — **error rate = 47 %**


1
2
3

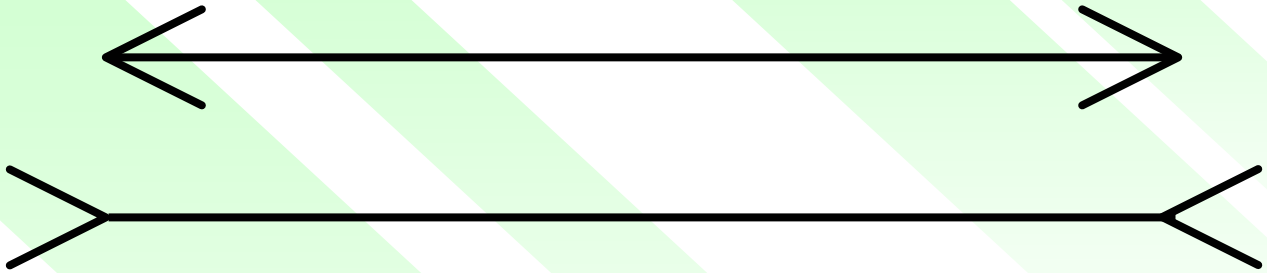
Trap # 7

Group failure

- **“Assuming that with many smart people involved, good choices will follow automatically, and therefore failing to manage the group decision-making process”**

Russo & Shoemaker

Optical Illusions



- Why illusions should only be limited to vision?
- Besides we use “vision” far more often than “decision”

What can be expected?

- **Criteria for good decision processes**
  - ➪ **Separate “facts” and “values”**
  - ➪ **Separate “robust” from “fragile” conclusions**
  - ➪ **Improve communication**
  - ➪ **Foster consistent reasoning**
  - ➪ **Draw attention to counter-intuitive and perverse effects**
  - ➪ **Promote open debate and discussion**
  - ➪ **Promote partial agreements**
  - ➪ **Promote reflection on objectives**

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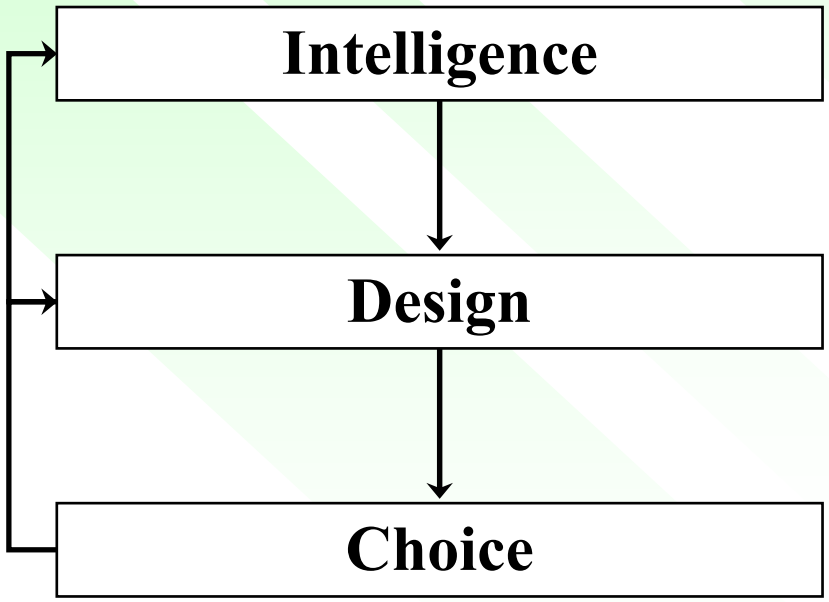
Simple Model of Decision Process

Herbert A. Simon (NP 1978)



Trap # 1

Plunging In

- **“Beginning to gather information and reach conclusions without taking first a few minutes to think about the crux of the issue you’re facing or to think how you believe decisions like this one should be made”**

Russo & Shoemaker

Trap # 10

Failure to audit your decision process

- **“Failing to create an organized approach to understanding your own decision-making, so you remain constantly exposed to all other nine decision traps”**

Russo & Shoemaker

Intelligence

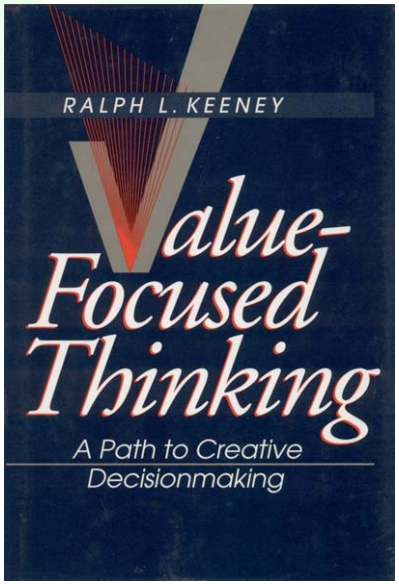
- **Four main activities**
  - ➪ **Entering a “decision process”**
  - ➪ **Reflecting on values (objectives)**
  - ➪ **Isolating a system**
  - ➪ **Imagining possible actions on the system**

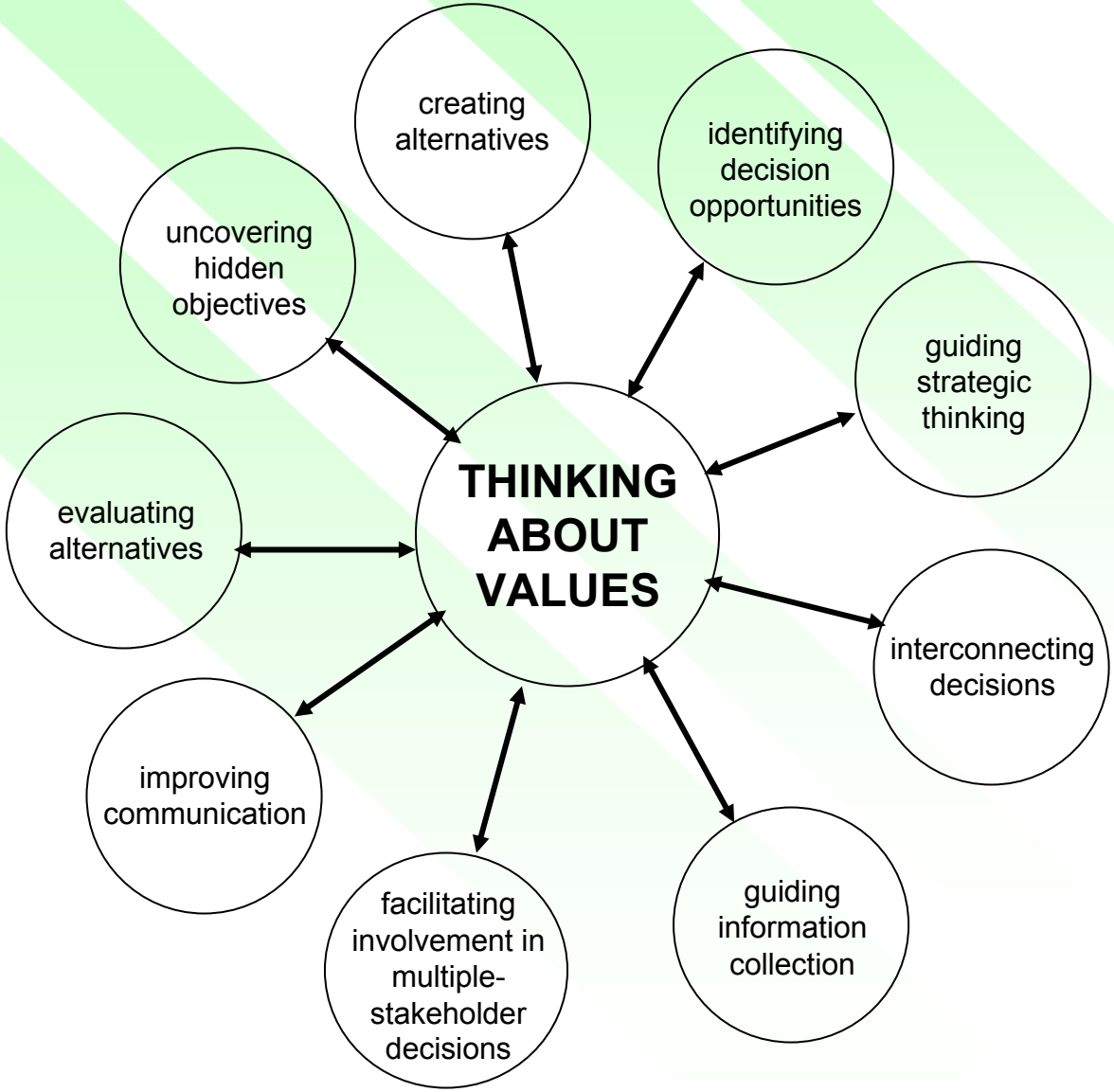
Triggers: Information Systems

- You cannot always be deciding…
- …something has to trigger the start of a decision process
  - ➪ MIS / EIS / Accounting / Inventory management
  - ➪ Watch
  - ➪ Prospective
- Information
  - ➪ of *adequate* nature and volume
  - ➪ in a *timely* manner

Values

- "Decision-Making is what you do to satisfy objectives" (R.L. Keeney)
- Objectives
  - ➪ guide the collection of information
  - ➪ facilitate communication
  - ➪ allow audits and evaluation
  - ➪ avoid endless debates
- Examples
  - ➪ Should we legalize cannabis?
  - ➪ What should be the objective of a public policy towards the control of psychotropic substances?





Adapted from Keeney, 19

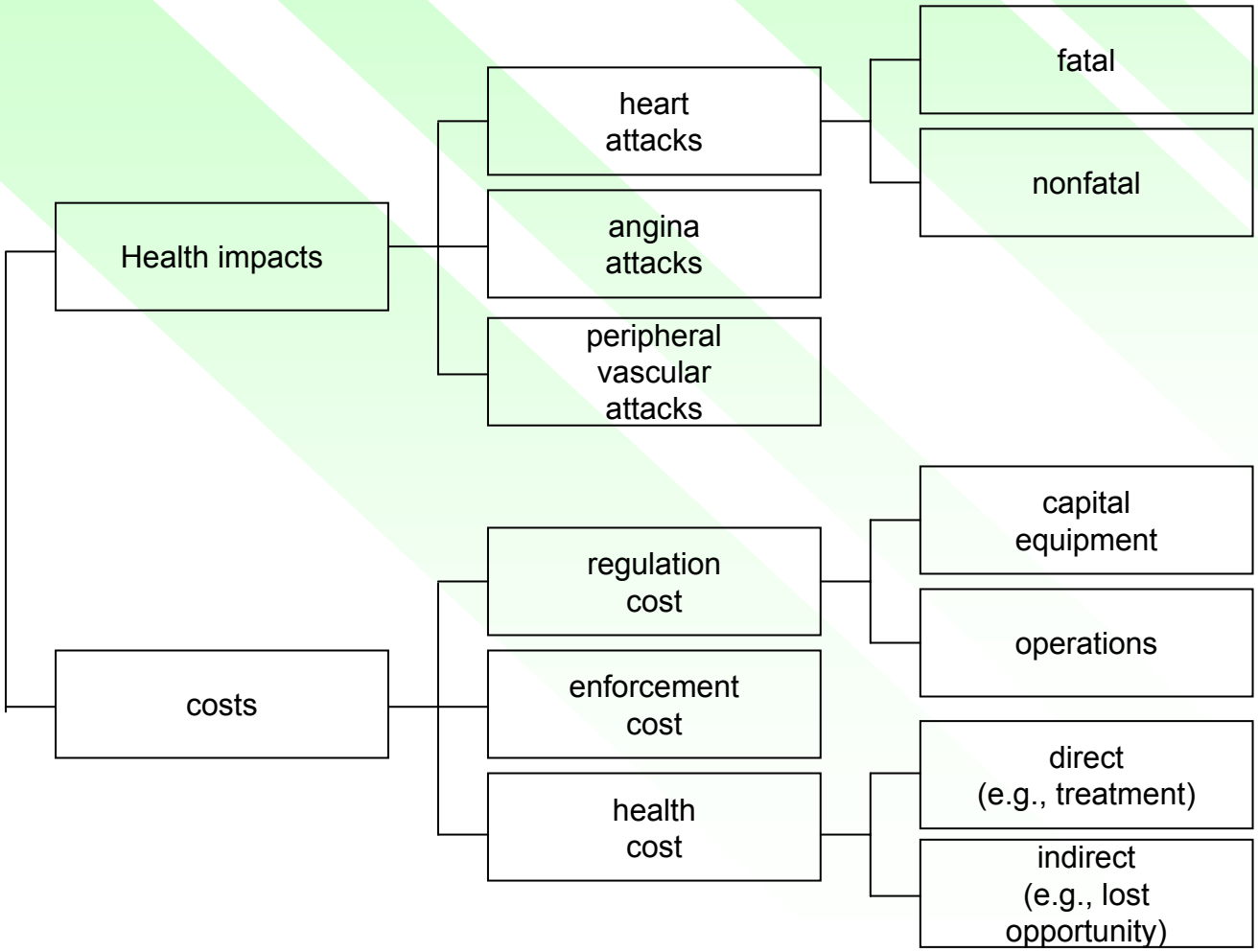
Values

- *Ends* objectives
  - *Why* is this important to me?
  - Evaluation
- *Means* objectives
  - *How* to reach my goals?
  - Alternatives
- *Means Objective*: an objective whose importance stems from its contributions to achieving another objective
- *Ends Objective*: objective that defines a basic reason for caring about a decision
  - Means Objective: arrive home from work early
  - Ends Objective: make my spouse happy

Techniques to Identify Objectives

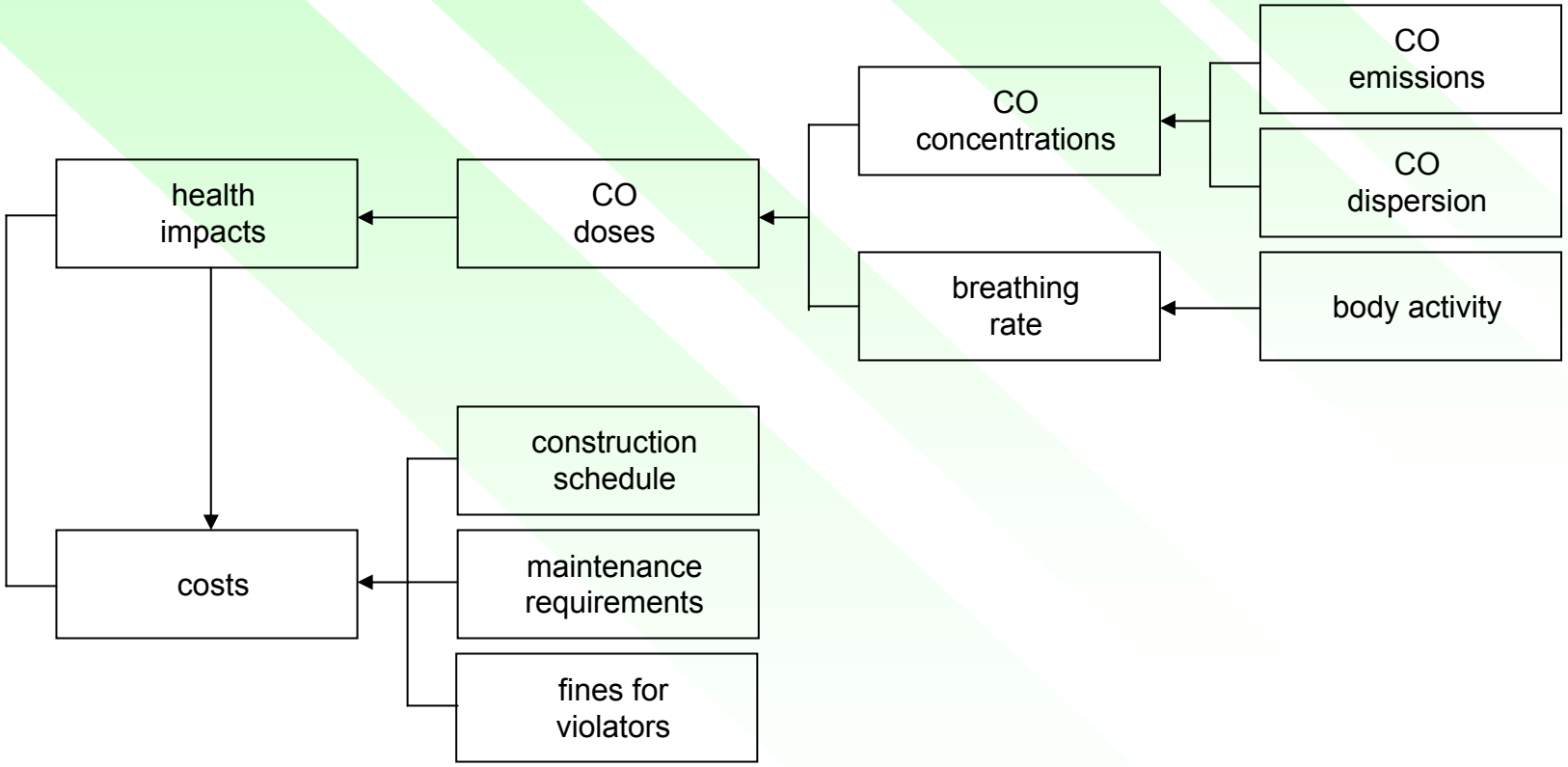
- Use a wish list
- Think about alternatives
- Imagine possible consequences
- Describe problems and shortcomings
- Identify goals, constraints and guidelines
- Use different perspectives
- Think about strategic objectives
- Ask ‘why’ for each objective
- Do individual thinking first

Fundamental Objectives Hierarchy
CO Air Quality Standards



Adapted from Keeney, 1992

Means-Ends Objectives Network
CO Air Quality Standards



Adapted from Keeney, 1992

Frontiers

- A model *has to* simplify (map / territory)
  - ⇨ Isolating a “system”
- Frontiers
  - ⇨ Time
  - ⇨ Space
  - ⇨ Persons
  - ⇨ Linked decisions
- Example
  - ⇨ Elevator

Frontiers

- Key points?
- Neglected points?
- Traps
  - ➪ metaphors, language
  - ➪ firm stereotypes
  - ➪ trigger
  - ➪ obvious constraints

Metaphors

- Sports / war / health, etc.
  - “winning team”
  - “price war”
  - “terminal phase”
  - “strategic movement”
  - “general mobilization”
  - “win the battle of quality”
  - etc.
- Is it always appropriate to think of decisions in terms of winning a battle?

Trap # 2

Frame Blindness

- **“Setting out to solve the wrong problem because you have created a mental framework for your decision with little thought that causes you to overlook the best options or lose sight of important objectives”**

Russo & Shoemaker

Trap # 3

Lack of Frame Control

- **“Failing to consciously define the problem in more than one way or being unduly influenced by the frames of others”**

Russo & Shoemaker

Example (Kahneman/Tversky)

- **You have decided to go to see a play and bought a ticket for 30 €**

  As you enter the theater, you discover that you have lost the ticket. The seat was not marked and the ticket cannot be recovered.

  Would you pay 30 € for another ticket to see the play (assuming you have enough cash)?

  - ⇨ **38% of subjects do not buy**

Example (Kahneman/Tversky)

- **You have decided to go to see a play where admission is 30 € per ticket, but you have not yet purchased the ticket. As you enter the theater, you discover that you have lost 30 € from your wallet.**

  Would you still pay 30 € for a ticket to see the play (assuming you have enough cash)?

  - ⇨ **17% do not buy (vs. 38%)**
  - ⇨ **Lost cash is "out-of-boundary"**

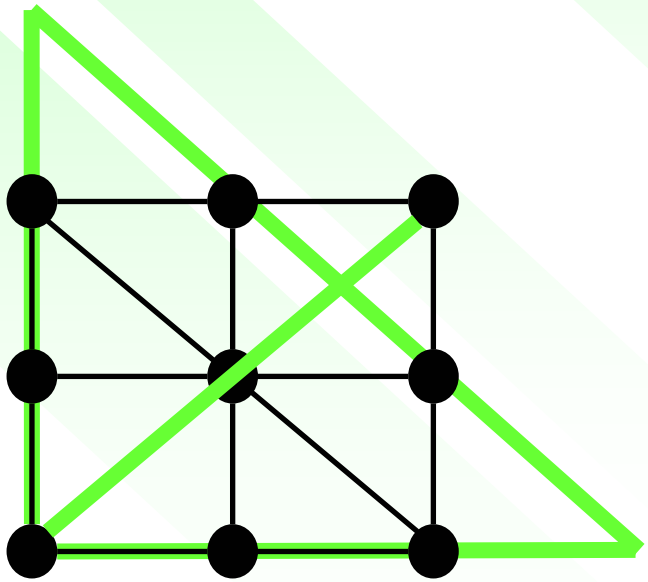
Imagining alternatives

- "Let *A* be a an exhaustive set of mutually exclusive alternatives"
- Creativity
  - ⇨ No really standard techniques
  - ⇨ Test: is there at least one satisfactory alternatives?

- R.L. Keeney
  - ⇨ "your decision cannot be better than your best alternative"
  - ⇨ "you can never choose an alternative you haven't considered"

Problem

- Join these 9 points by 4 lines without lifting the pencil from the paper



“Creativity Killers”

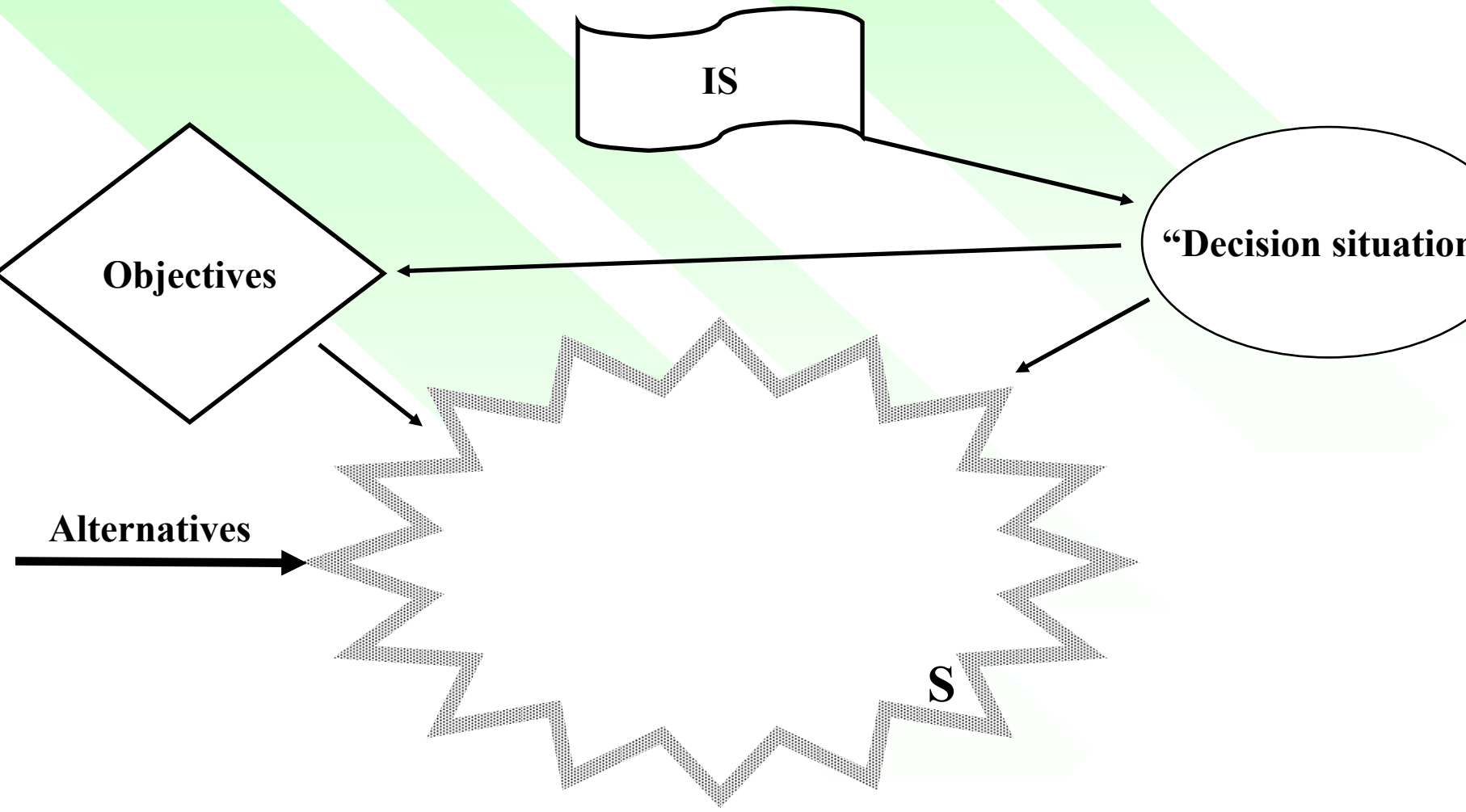
- “Business as usual”: budgets
- Status-quo bias
- No action: letting time/others decide for me
- Fear of being ridiculous
  - ⇨ “brainstorming sessions”
  - ⇨ US army

Remedies

- Use your objectives and ask: how do I achieve them?
- Increase aspiration levels
- Beware of (implicit) constraints
- Sleep on it
- Modify / improve what is “given”: nothing is “given”

- Test: Is there anything really satisfactory?

Intelligence Phase



Design

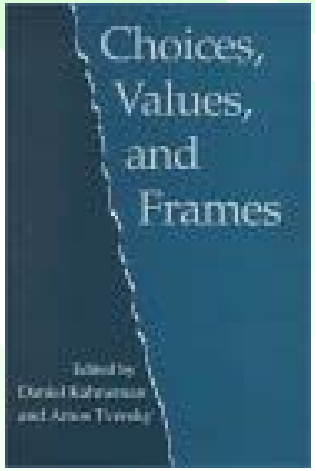
- Describe/forecast the “state of the system” if you apply some alternative
- Examples: most management techniques
  - sales forecasts, financial plans, accounting
- Choosing a job
  - salary
  - learning
  - transportation time
  - social security
  - nights out
  - interest
  - chances of keeping the job

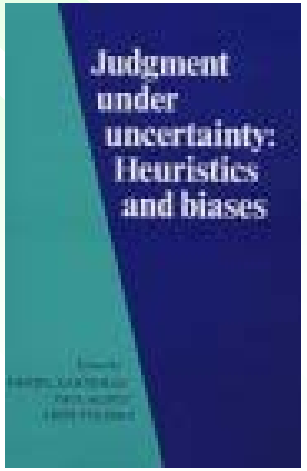
Traps

- Not having objectives
- Not using your objectives
- Fetish “hard data”
- Not taking uncertainty into account
- Mixing up “knowledge” of experts with their “values”
  - ➪doctors
- Design: crucial points
  - ➪What do I know?
  - ➪What should I know?

More traps

- **Reference points**
- **Units**
  - **nature of the measure**
  - **absolute/relative**





Example (Kahneman/Tversky)

- Experiment with 167 doctors
- Choice of a treatment for (own) lung cancer
  - ⇨ Surgery
  - ⇨ Radiotherapy
- Information on survival “chances”
  - ⇨ 2 groups

100 patients Surgery	10 die during operation
	32 are dead after 1 year
	66 are dead after 5 years
100 patients radioth.	0 die during operation
	23 are dead after 1 year
	78 are dead after 5 years

50 % in Group 1 prefer Surgery

100 patients Surgery	90 survive to operation
	68 survive after 1 year
	34 survive after 5 years
100 patients radioth.	100 survive to operation
	77 survive after 1 year
	22 survive after 5 years

84 % in Group 2 prefer Surgery

100 patients Surgery	10 die during operation
	32 are dead after 1 year
	66 are dead after 5 years
100 patients radioth.	0 die during operation
	23 are dead after 1 year
	78 are dead after 5 years

100 patients Surgery	90 survive to operation
	68 survive after 1 year
	34 survive after 5 years
100 patients radioth.	100 survive to operation
	77 survive after 1 year
	22 survive after 5 years

Measurement units

- **Public Health decisions**
  - ⇨ **Number of fatalities**
  - ⇨ **Number of years of life lost**
  - ⇨ **Number of years of "good quality" life lost**
    - **QUALY, HYE**

Absolute/Relative measurement

- **Situation A**

  Watch = 70 €

  You are told by a friend that, five blocks away, you can buy the same watch (same service and guarantee) at 30 €

Question: Are you going to buy the watch in the distant shop?

(90% Yes)

- **Situation B**

  Video camera = 800 €

  Five blocks away, you can buy the same video (same service and guarantee) at 770 €

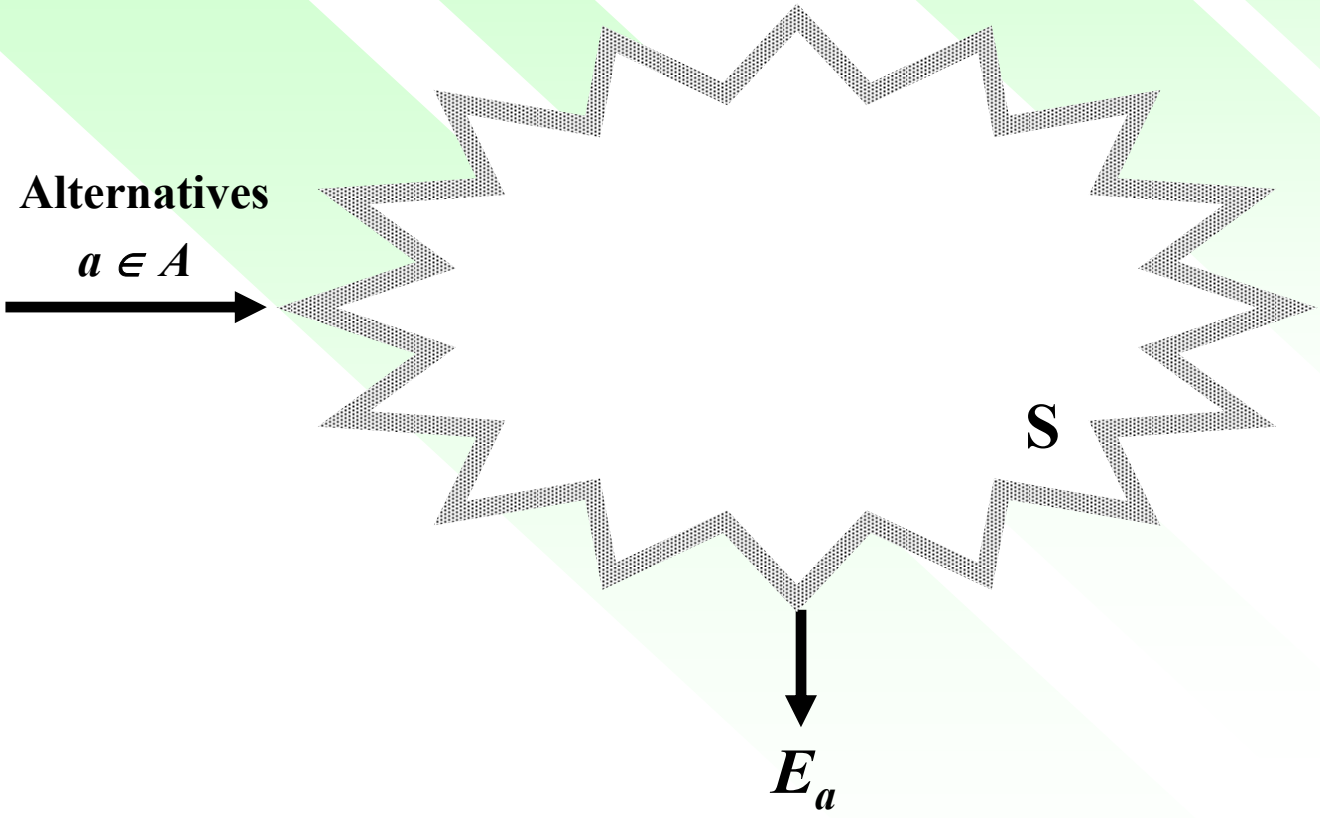
Question: Are you going to buy the video in the distant shop?

(50% Yes)

Absolute/Relative measurement

- **Budget: 100 000 €**
- **Expenditures: 90 000 €**
  - ⇨ **“I saved 10 000 € to the firm”**
- **Expenditures: 110 000 €**
  - ⇨ **“I stayed with 10% of the budget”**

Design Phase

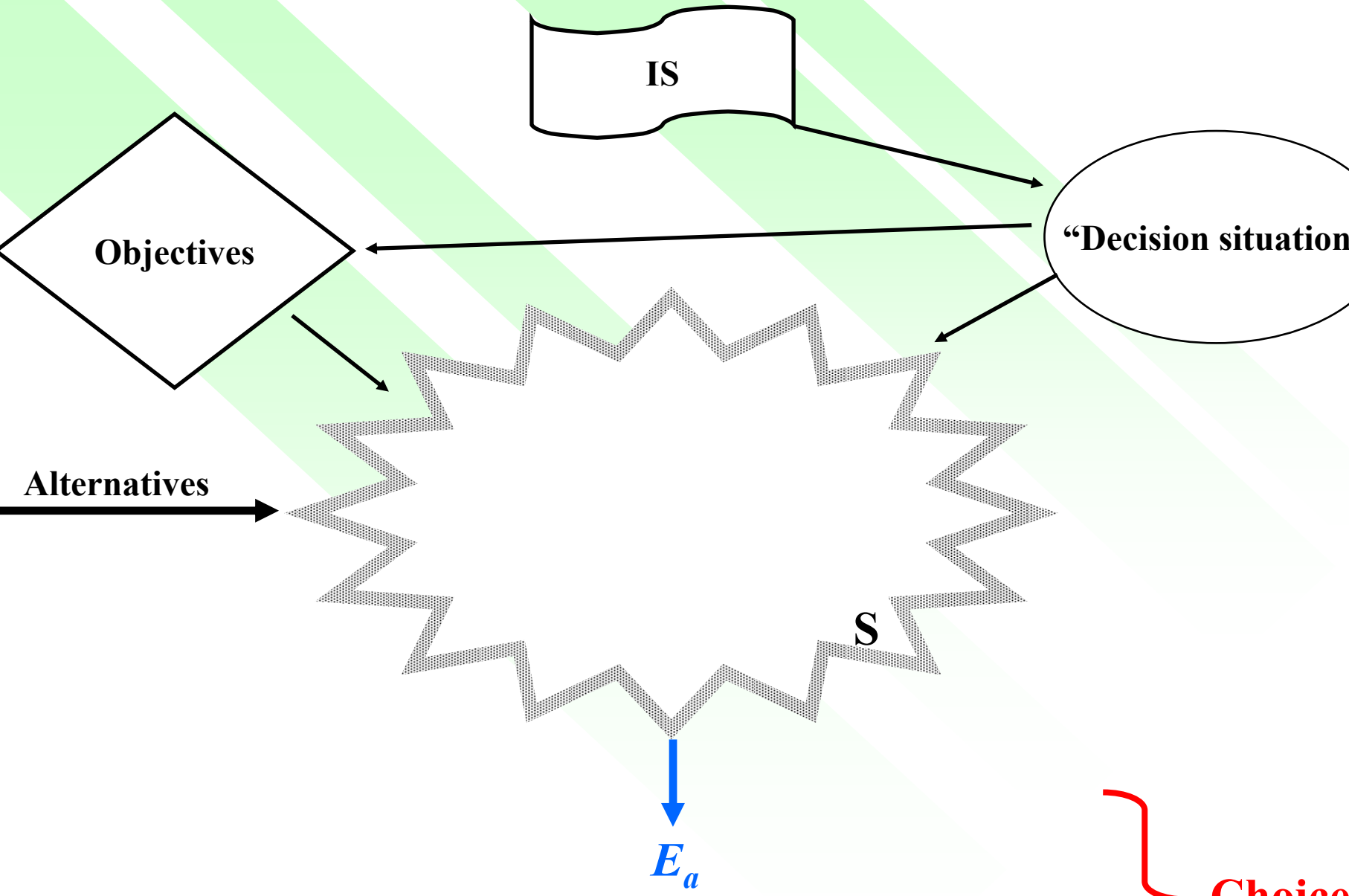


Description of the system if you apply alternative $a \in A$

Choice Phase

$a \in A \rightarrow E_a$
$b \in A \rightarrow E_b$
$c \in A \rightarrow E_c$

- Choose alternative giving to system the "most desirable" state
- Complexity depends on:
  - A (set of alternatives)
  - S (system)
  - E_x (description of system) / objectives
    - precision/imprecision
    - certainty/uncertainty
    - Time horizon
    - 1 opinion / multiple opinions
    - 1 criterion / several criteria


IS
Objectives
“Decision situation
Alternatives
S
E_a
Description of system if $a \in A$ is implemented
Choice

Example: Optimization

- A is stable; alternatives are exclusive
- System and objectives allow to summarize E_a by a unique *performance measure*
- Examples
  - ⇨ Profit, Sales, Quality, Jobs, Pollution level, etc.
- $a \in A \rightarrow E_a \rightarrow f(a)$

E_a preferred to E_b $\Leftrightarrow$ $f(a) > f(b)$

E_a indifferent to E_b $\Leftrightarrow$ $f(a) = f(b)$

Optimization

- **Choose an alternative $a \in A$ making**
  {Maximum *or* Minimum}
  the performance measure $f(a)$

$$\max_{a \in A} f(a) \quad \text{or} \quad \min_{a \in A} f(a)$$

- **Optimize = Maximize or Minimize**
  depending on the nature of $f(a)$

"Optimal decision" contingent to:

- **Objectives**
- ***S*: System**
- ***A*: set of alternatives**
- **E_a: Description of consequences**
- **Optimization model is an *aid* to decision**
  - ⇨ **discuss/modify the optimal solution**
  - ⇨ **integrate neglected aspects**
  - ⇨ **Redefine *S*, *A* or E_a**
- **In many cases the very idea of an "optimal solution" is meaningless**

Meta Decision

- **How much time to allocate to each phase?**
- **Design: 80% of time (crunching numbers not to think hard)**

	real	wished
Intelligence	5%	20%
Design	45%	35%

Russo & Shoemaker

Trap # 9

Not keeping track

- **"Assuming that experience will make its lessons automatically, and therefore failing to keep systematic records to track the results of your decisions and failing to analyze these results in ways that reveal their key lessons"**

Russo & Shoemaker

Generic problems in the Choice phase

- Very high number of alternatives
- Interdependent decision
  - ⇨ resources
  - ⇨ time
- Uncertainty
- Time Horizon
- Multiple Criteria
- System with retro-action
- Group Decision

In Practice

- All difficulties are more or less present
- Design phase will put more emphasis on one or two depending on context
- Sometimes “Intelligence + Design” are enough to give sufficient insights into the situation
  - ⇨ Solving vs. dissolving “problems”

Outline

- Classical view on decision
- Another view
- What can be expected?
- What should we take care of?
- What are the main types of models?

Decision analysis tools
(Classical techniques for generic problems)

- **Very high number of alternatives**
- **Interdependent decision**

Mathematical Programming

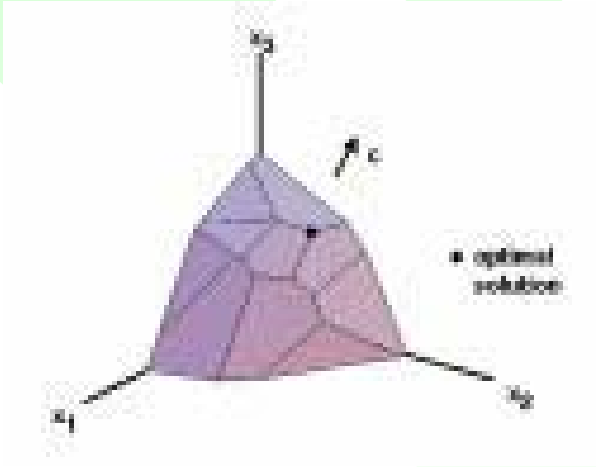
Combinatorial Optimization

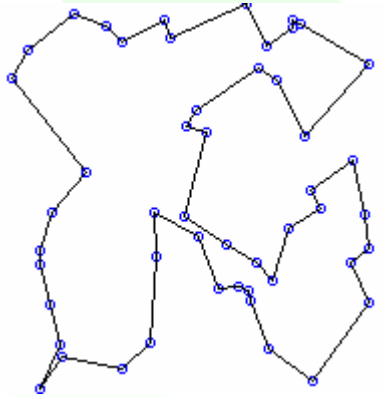
- **Uncertainty**

Bayesian Decision Theory

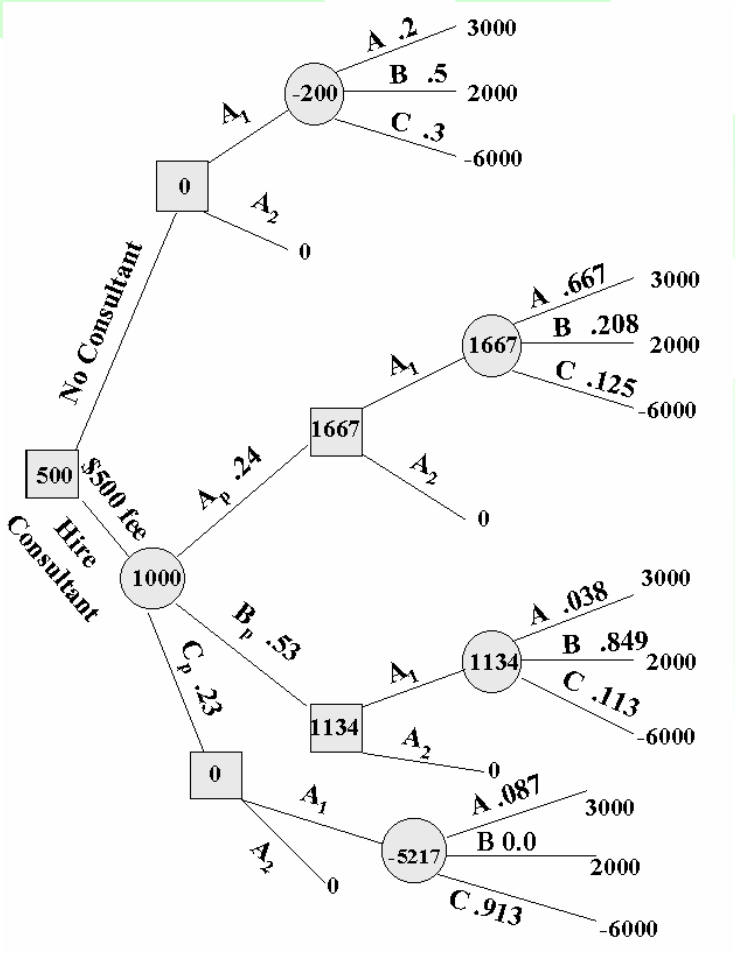
Fuzzy sets

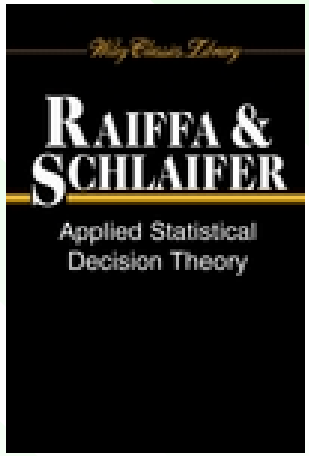
Mathematical Programming and Combinatorial optimization





Decision trees





Pascal's wager

	Jesus' claims false	Jesus' claims true
I accept	some disappointment	infinite reward
I reject	no big deal	consider carefully!!! don't let it happen

Classical techniques

- **Time**

Dynamic Programming - Optimal Control -

[*Sustainable Development*]

- **Retroactions**

Game Theory

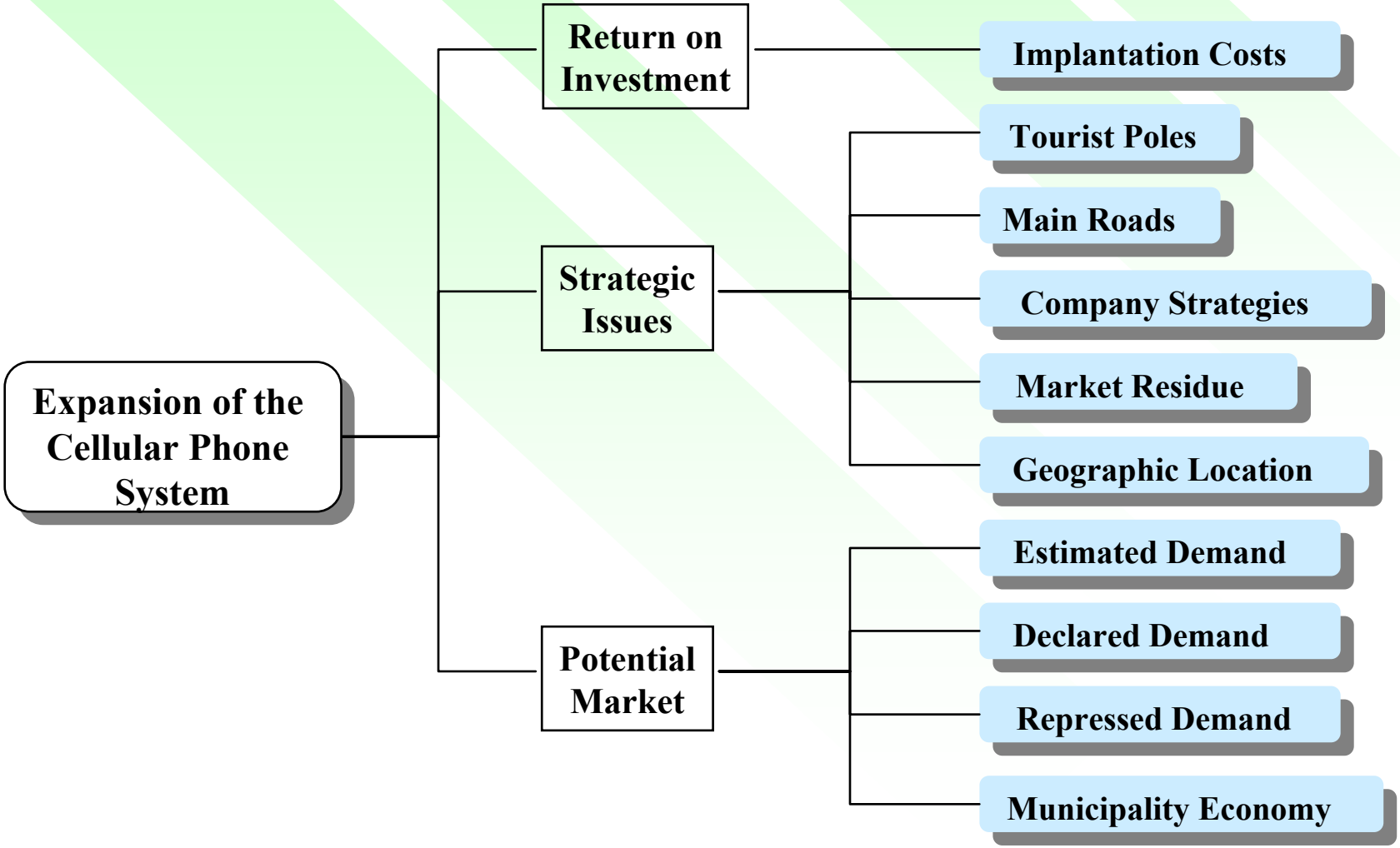
- **Group Decisions**

Social Choice Theory – Negotiation analysis

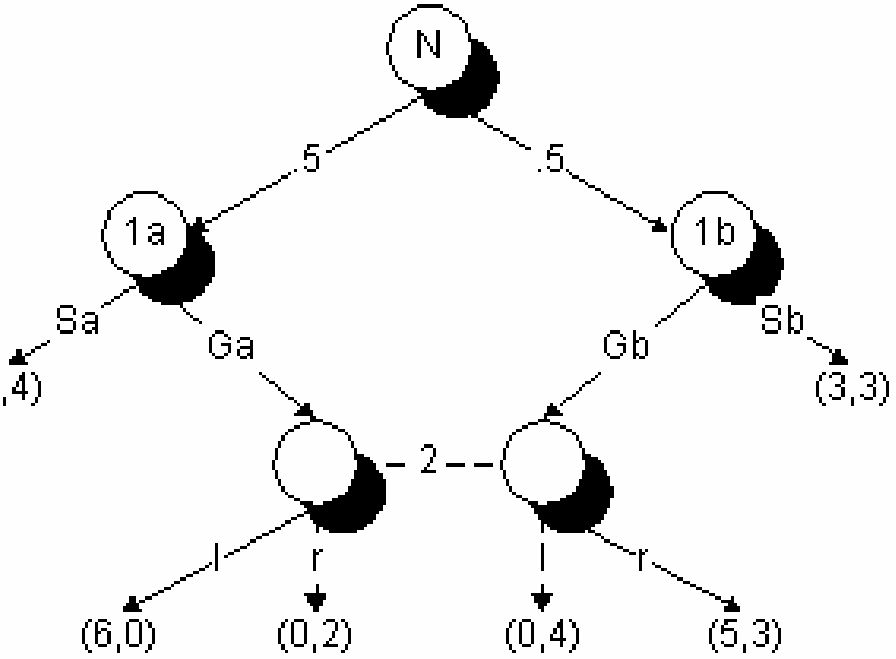
- **Multiple Criteria**

MCDM / MCDA

MCDM


Expansion of the Cellular Phone System
Return on Investment
Strategic Issues
Potential Market
Implantation Costs
Tourist Poles
Main Roads
Company Strategies
Market Residue
Geographic Location
Estimated Demand
Declared Demand
Repressed Demand
Municipality Economy

Game trees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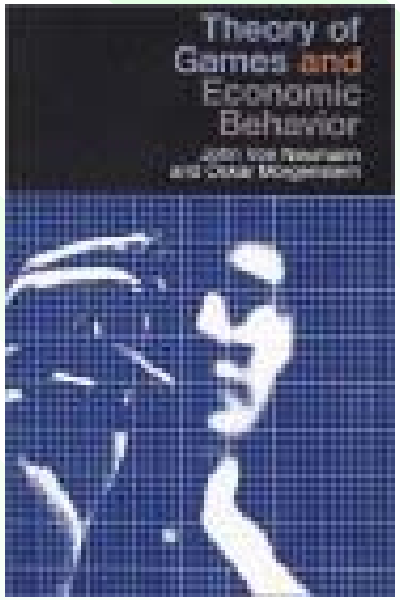
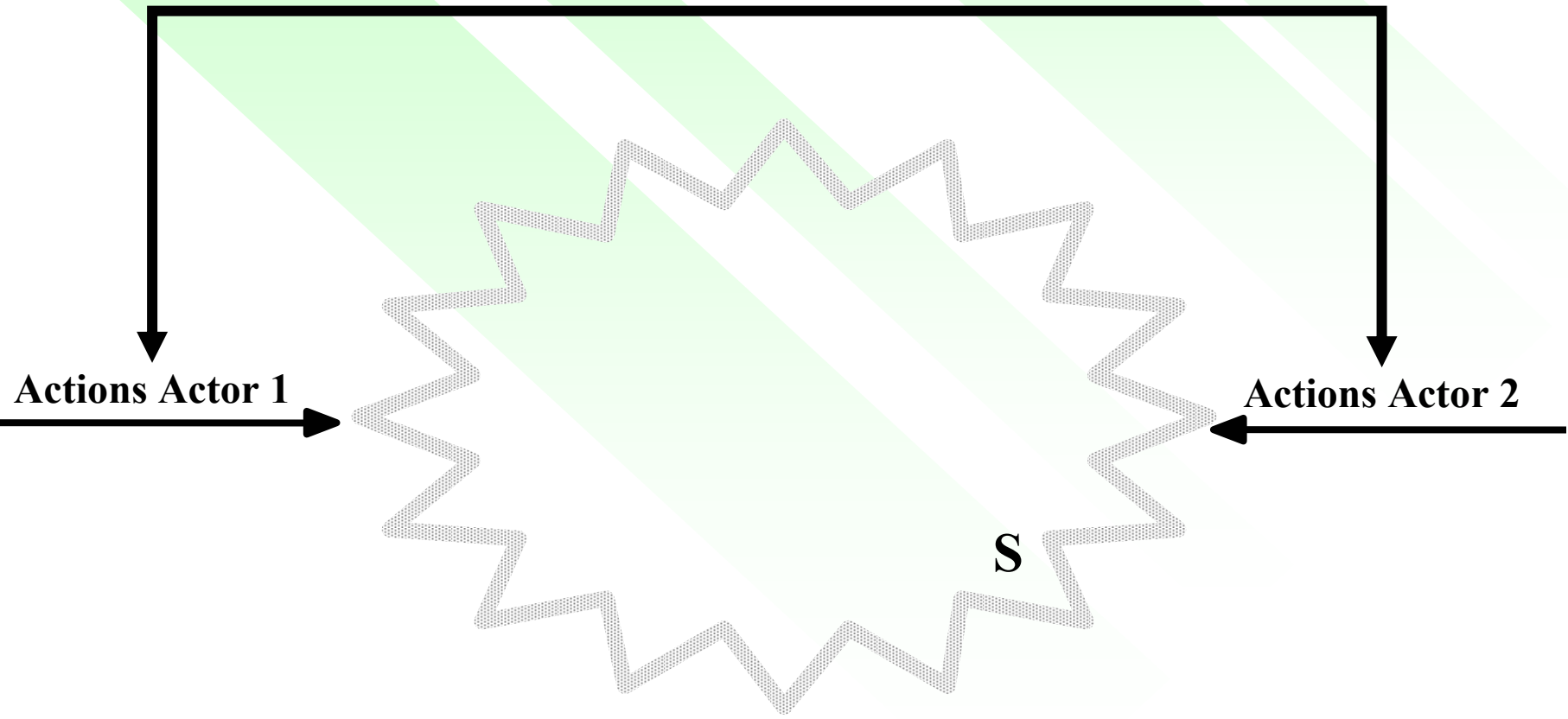

Theory of
Games and
Economic
Behavior


GAMES AN
DECISION

A final trap

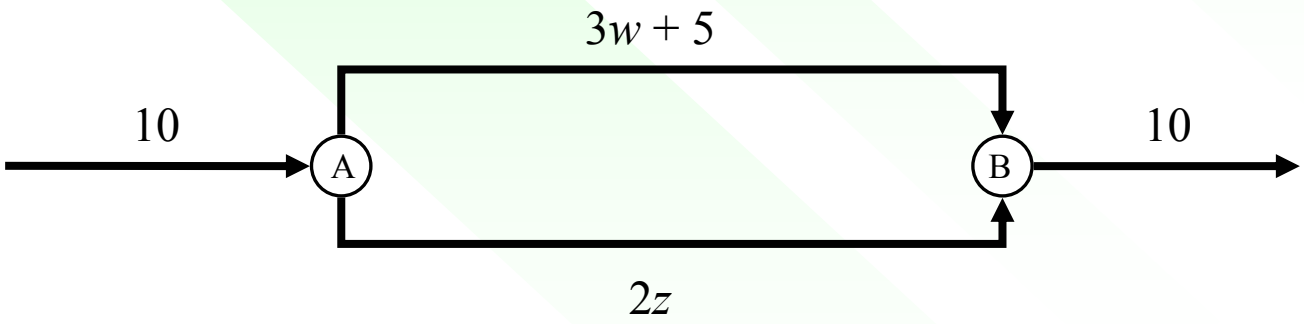
- **Confuse Decision Analysis with the application of generic techniques**
  - **Decision Analysis consists in an *intervention* in a decision process**
  - **Tools are more or less restricted to the Choice phase**
  - **Sophisticated tools in the Choice phase cannot compensate for weaknesses in the Intelligence and Design phases**

Example: retroaction



"Competition" on a network

- **Road network: point A to point B**
  - **10 Kusers**
  - **2 routes**
  - **travel time ("cost") = *f*(# of users on route)**



Liberal Regulation

- Informed users choose the route according to travel times
- Equilibrium if cost of two routes is equal
  - $3w + 5 = 2(10 - w) \Rightarrow w = 3$
  - 3 Kusers on upper route (cost = 14)
  - 10 – 3 = 7 Kusers on lower route (cost = 14)
- Each user “pays” 14
- Social “cost” = 140 (time lost in the network)

Bureaucratic Regulation

- A bureaucrat located at point A makes the choices for the users. S/he wishes to minimize total social cost

  $CT(w) = w(3w + 5) + 2(10 - w)^2 = 5w^2 - 35w + 200$

- Minimization

  $CT'(w) = 10w - 35 = 0 \Rightarrow w = 3{,}5$

  - ⇨ 3,5 Kuser on upper route each paying:

    $(3 \times 3{,}5 + 5) = 15{,}5$

  - ⇨ 6,5 Kusers on lower route each paying:
  - ⇨ $2 \times 6{,}5 = 13$

- Social cost = $3{,}5(3 \times 3{,}5 + 5) + 2(10 - 3{,}5)2 = 138{,}75$
- Efficiency *vs.* Justice??

Outline

- Classical view on decision
- Another view
- What can be expected?
- What should we take care of?
- What are the main types of models?
- Conclusions

What to remember?

- Inadequacy of the classical view of decision
- Decision as a process generating anxiety
- Decision analysis as a methodology to get along in spite of this anxiety
- Deciding is not solving a well-defined problem
- Three main phases: Intelligence, Design, Choice
- Formal techniques for generic problems in the choice phase
- Informal hints for the other phases
- Decision aiding means intervening in a decision process

Research / Questions / Problems

- **Integration of decision analysis tools**
- **Validation**
  - ⇨ **rationality?**
  - ⇨ **checking the profession?**
  - ⇨ **training novices?**
- **Organizing the decision aiding process**
  - ⇨ **consistency and meaningfulness?**
  - ⇨ **legitimating?**