INTRODUCTION TO MULTICRITERIA DECISION ANALYSIS (MCDA)

02 – Concepts and starting examples

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SNEAK PEEK

Today we are going to explore MCDA in a more formal way (definitions, basic components, problems, etc.).

I hope you had time to read the materials I selected, but if you didn't it's ok (for today, next week it is a different story).

TABLE OF CONTENTS

What does MCDA stand for?

To start with it can be called in a lot of different ways:

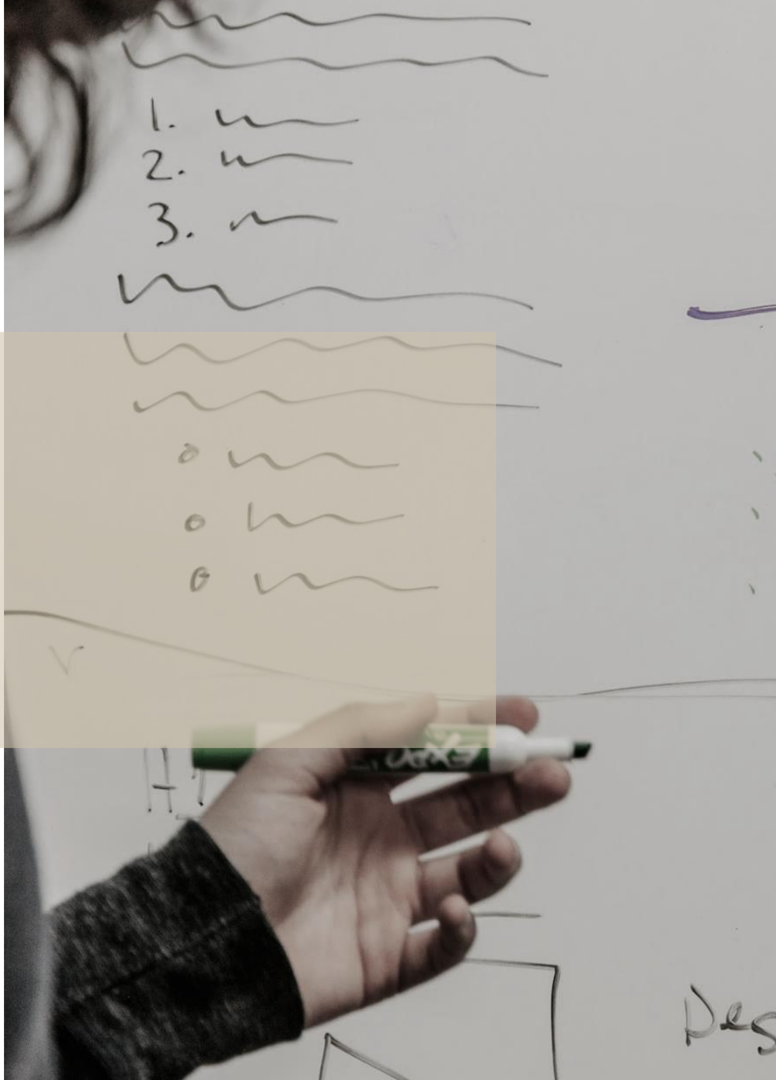
1. **Multicriteria decision analysis (MCDA)**
2. **Multicriteria decision methods (MCDM)**
3. **Multicriteria decision making (MCDM)**
4. Multicriteria decision and classification (MCAC)
5. Multicriteria optimization (MCO)
6. Multicriteria analysis (MCA)
7. Conjoint analysis (CA)*
8. Discrete choice experiments (DCE)*
9. …. *and counting*

** Researchers in MCDA view CA and DCE as subfields of MCDA. CA and DCE researcher do not always agree with that. Most MCDA manuals include CA and DCE as chapters.*

Is MCDA a method?

- Actually, **MCDA is not a method**, but rather an umbrella concept
- **MCDA is better understood as a family of methods or approaches that share the same goal**.

- **A basic definition:**
- *"Thus, we use the expression MCDA as an umbrella term to describe* ***a collection of formal approaches*** *which seek to* ***take explicit account of multiple criteria*** *in* ***helping individuals or groups explore decisions that matter****."* (Belton and Stewart, 2002)



How many methods?

- **How many MCDA methods are there?**
  - No one knows because there are many, and each day more are developed and there are many, many versions, slight changes and implementations to methods.

- **Example**: ELECTRE is not one method but a family of methods:
  - ELECTRE I
  - ELECTRE II
  - ELECTRE III
  - ELECTRE IV
  - ELECTRE IS
  - ELECTRE TRI
  - (*and many many versions and fine-tuned implementations*)

  - *Which means families of families….*

When is MCDA used?

- Is used when:
    - **Decisions often involve several factors** (price, quality, safety, etc.).
    - In complex decisions, **relying on intuition alone is insufficient**.
    - **Mistakes are costly or irreversible**.
    - **Information is too complex** to process mentally.
    - **Multiple stakeholders** may have **different priorities**.
    - **Criteria are in conflict** (e.g., cost vs. quality).
    - **Decisions impact multiple people** and have **long-term consequences**.

- MCDA organizes information and helps make confident choices.
    - A structured way to compare options.
    - A method to integrate different perspectives.
    - Confidence in decision-making through transparency.

MCDA MYTHS

“RIGHT ANSWER”

MCDA solves problems by providing *the* right answer to your questions.

“OBJECTIVE”

MCDA is a fully *objective* analysis that takes the responsibility of the decision, especially difficult ones, away from the decision makers.

“EASY”

MCDA will take away the pain of making decisions and they will magically become simple and easy.

“BEST ONE”

There is *the* best MCDA method and all others are useless.

“RIGHT ANSWER”

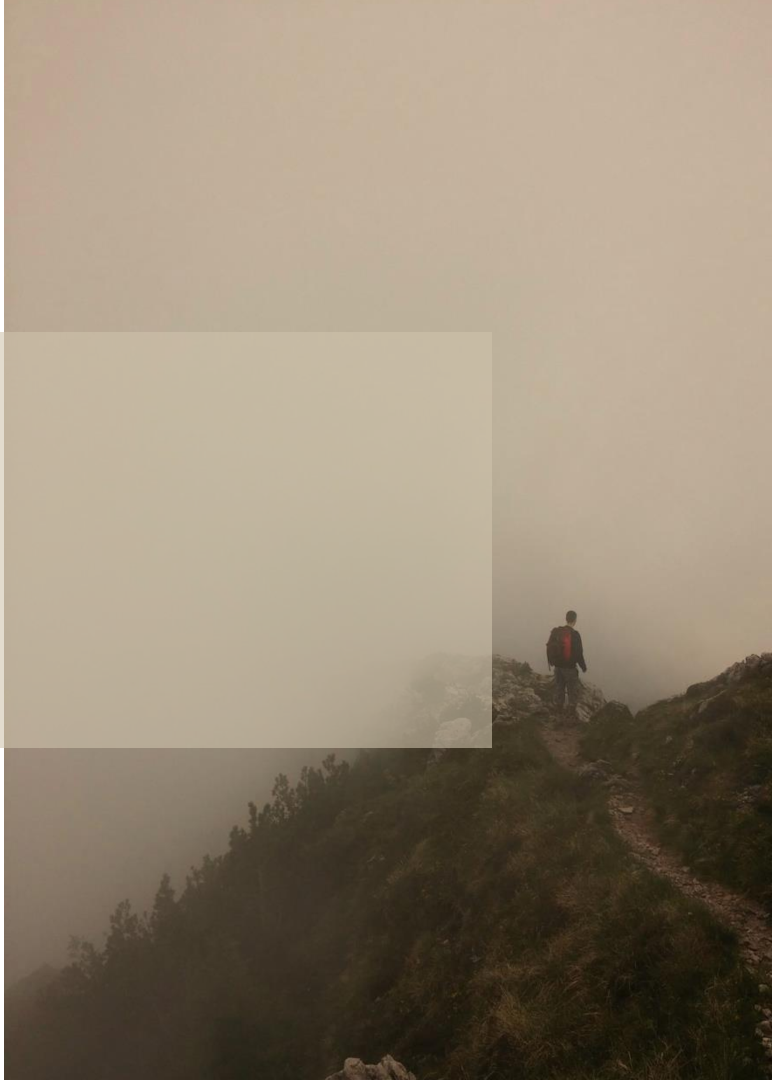
- There is no “right” answer in MCDA and often even within an MCDA model you collected data to make a decision.
- The concept of “optimum” does not exist within the MCDA universe because the same problem can be tackled in a plethora of different methods, yielding different results.
- As such, MCDA provides suggestions to decisions but not “perfect” answers as in Operational Research.
- However, MCDA aids decision makers to make better, more informed, less subjective decisions.

- While it is a “quantitative” method, it is in many aspects a more “qualitative” interpretation of a situation*.

“OBJECTIVE”

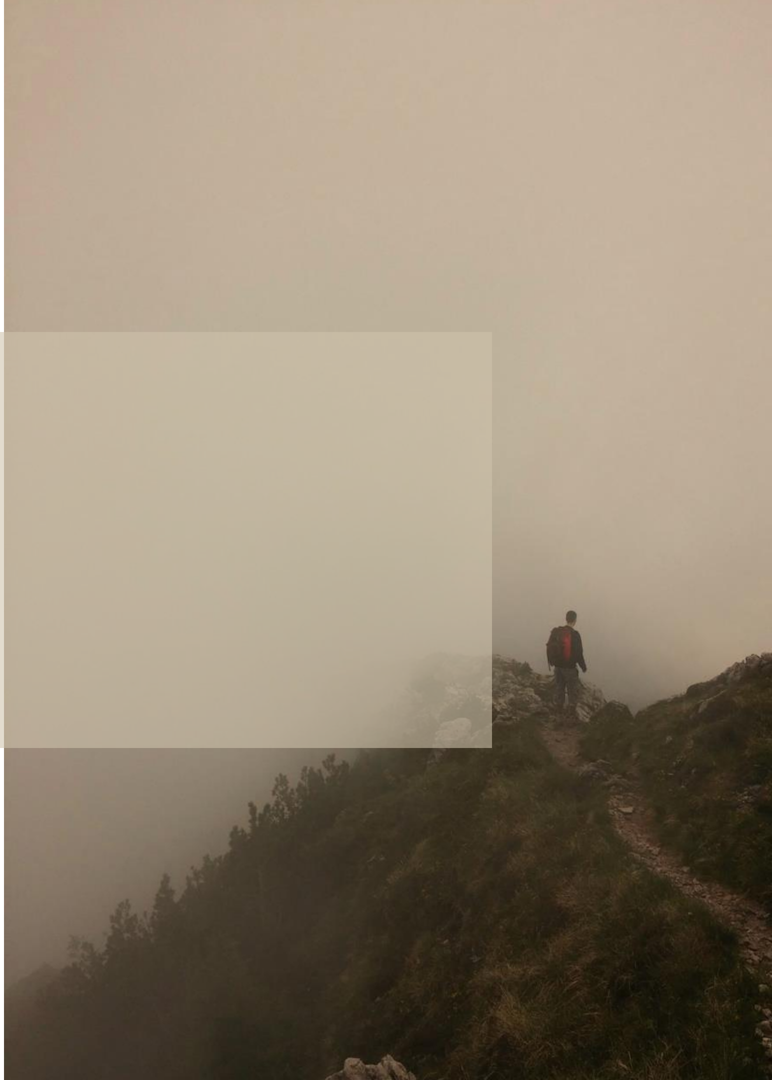
- Subjectivity is inherent in any decision-making process and in MCDA as well.
- So many things can change the outcome of an MCDA process:
    - How many criteria you choose
    - Which ones you choose
    - How you frame the problem
    - The weight we give to criteria
    - The order of the criteria presented
    - Who you choose as decision makers
    - …

- But it is still better than simple heuristics in complex scenarios.



“OBJECTIVE”

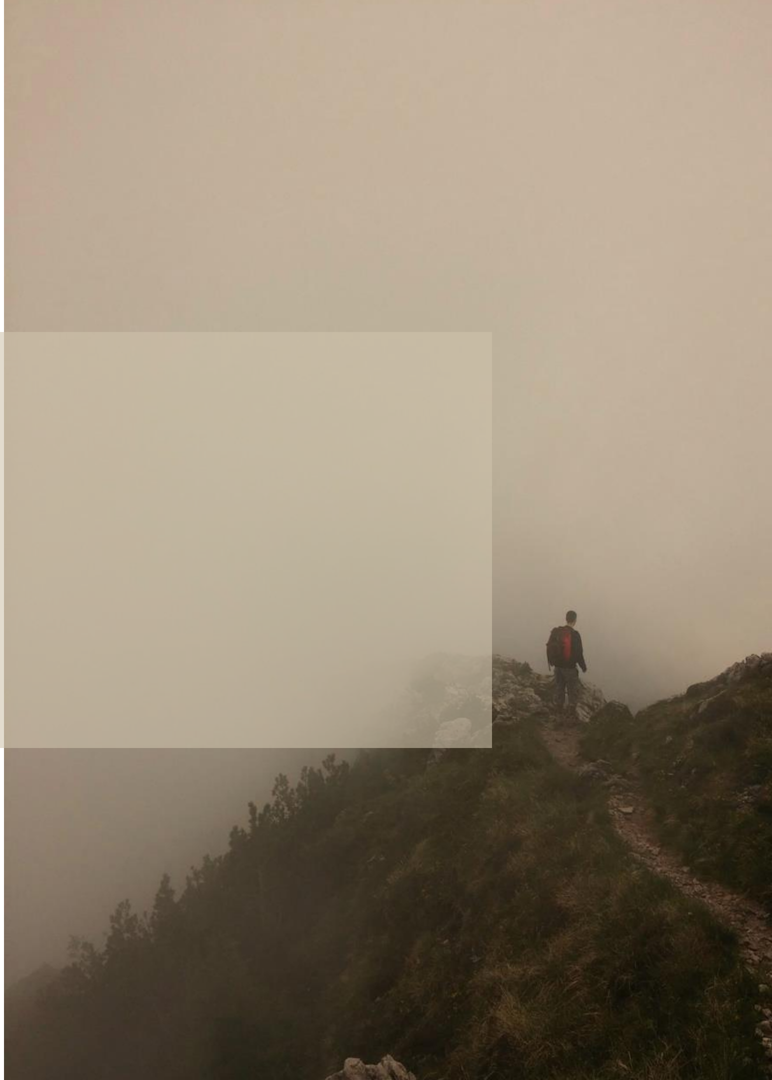
- The border between feasible and not feasible is often fuzzy in real decision contexts.
- Preferences over criteria are seldom well shaped and clear.
- The same decision maker would possibly respond differently to the same criteria if presented to the same decision twice.
- Data is often imprecise, uncertain and ill defined.
- A decision is neither good or bad based on math alone, and other external aspects influence choice and its success.



“EASY”

- As you will see very soon, doing an MCDA process can be a lot of work.
- Trade-offs are difficult (especially when ethical and humane circumstances are involved).
- Trade-offs cannot simply be avoided.
- MCDA is useful but one really needs to think about the “cost-benefit” ratio before using it.
- Collecting data, cleaning data, understanding data (as other quantitative methods) is also a long task (depending on the method / software as well).

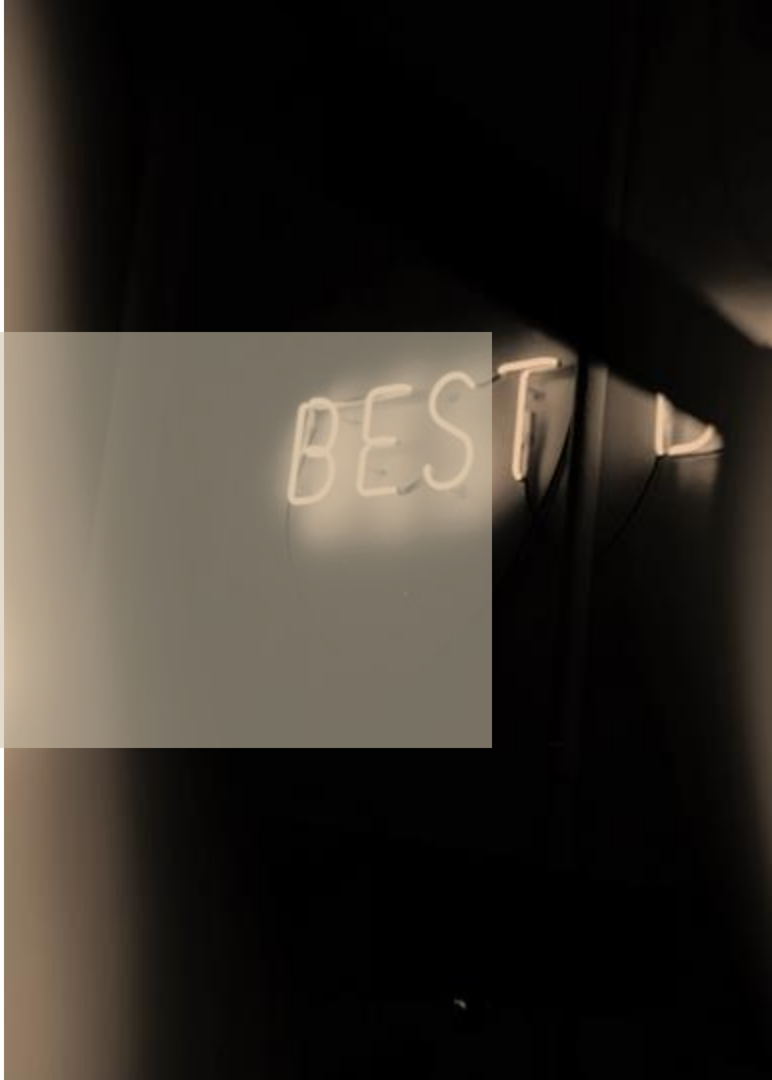
- In the end MCDA methods help in mitigating subjectivity but cannot take it away completely, which means every judgment is still somewhat imprecise.

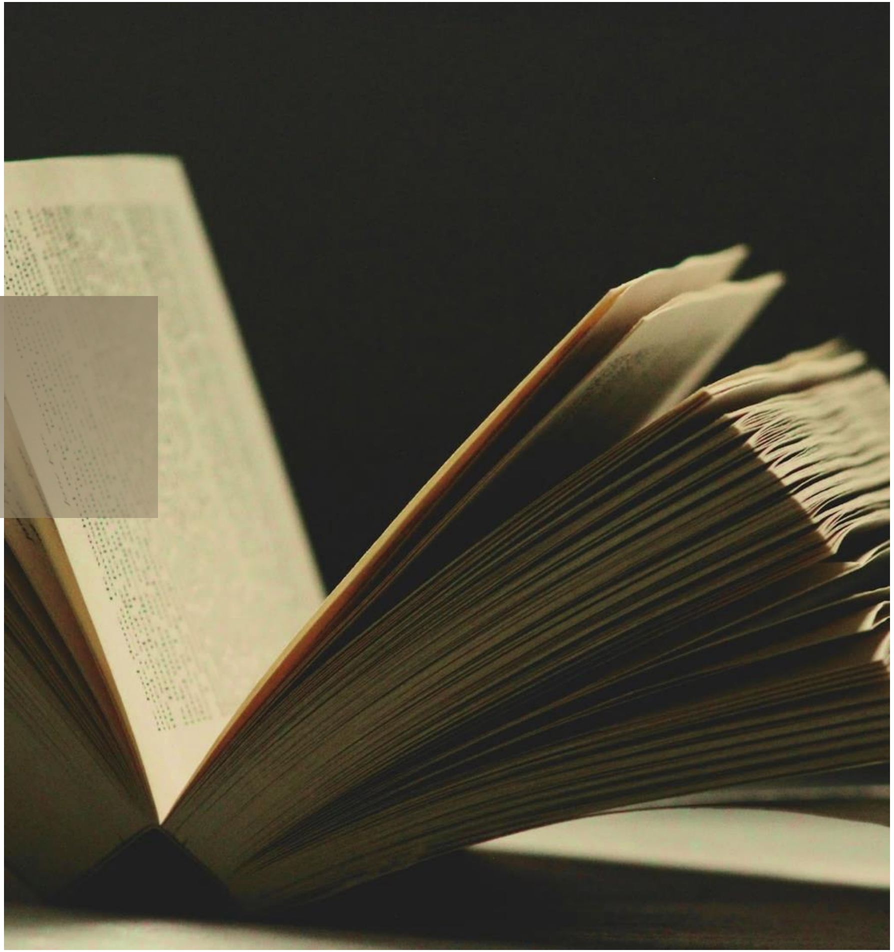


“BEST ONE”

- While all MCDA methods have the same goal, they try to achieve this in a lot of different ways.
- They vary in philosophy, mechanics, calculations, etc.
- In addition, it is quite common for researchers to tweak methods for specific purposes, which means there are many variations of the same method.
- We would expect all methods to converge to the same order and recommendation of “best alternatives” but because of the aforementioned points, it is not always the case.

- However, researchers have *strong* preferences over methods and *even stronger* criticisms over certain methods. Lots of feuds happened because of that.
- PS: I do have my own preferences and criticisms. You’ll hear them in due time.





MCDA QUOTES

after all, what is it?

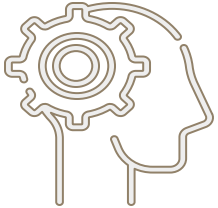
MCDA QUOTES

Quotes

- “Simply stated, the major role of formal analysis is to **promote good decision making**. Formal analysis is meant to **serve as an aid to the decision maker, not as a substitute for him**. As a process, it is intended to **force hard thinking about the problem area**: generation of alternatives, anticipation of future contingencies, examination of dynamic secondary effects and so forth. Furthermore, a good analysis should illuminate controversy - to find out where basic differences exist in values and uncertainties, to facilitate compromise, to increase the level of debate and to undercut rhetoric - in short "to promote good decision making" (Keeney and Raiffa, 1972, pp 65-66)

- “… decision analysis [has been] **berated because it supposedly applies simplistic ideas to complex problems**, usurping decision makers and prescribing choice! Yet I believe that it does nothing of the sort. I believe that decision analysis is a very delicate, subtle tool that **helps decision makers explore and come to understand their beliefs and preferences in the context of a particular problem that faces them**. Moreover, the language and formalism of decision analysis **facilitates communication between decision makers**. Through their greater understanding of the problem and of each other's view of the problem, **the decision makers are able to make a better informed choice**. **There is no prescription: only the provision of a framework in which to think and communicate**.” (French, 1989, p 11)

- “**We wish to emphasize that decision making is only remotely related to a "search for the truth."**" [...] the theories, methodologies, and models that the analyst may call upon [...] are designed to **help think through the possible changes that a decision process may facilitate** so as to **make it more consistent with the objectives and value system of the one** for whom, or in the name of whom, the decision aiding is being practised. These theories, methodologies, and models are **meant to guide actions in complex systems**, especially when there are conflicting viewpoints.” (Roy, 1996, p 11)



MCDA QUOTES

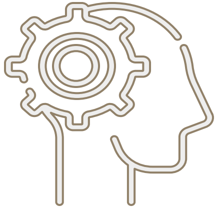
Quotes

- “The decision unfolds through a process of learning, understanding, information processing, assessing and defining the problem and its circumstances. **The emphasis must be on the process, not on the act or the outcome of making a decision**...” (Zeleny, 1982)

- “... decision analysis **helps to provide a structure to thinking**, a **language for expressing concerns of the group** and a **way of combining different perspectives**.” (Phillips, 1990, p 150)

- Decision aiding is the activity of people using models (not necessarily completely formalized ones) to **help to obtain elements of responses to the questions asked by a stakeholder** in a decision process. These elements work towards **clarifying the decision** and usually **towards recommending, or simply favoring, a behavior** that will **increase the consistency between the evolution of the process and this stakeholder’s objectives and value system**. In this definition, the word “recommending” is used to draw attention to the fact that **both analyst and decision maker are aware that the decision maker is completely free to behave as he or she sees fit after the recommendation is made.** (Roy in Ehrgott et al,. 2016, p 20)

- *These are not my words, but words from the very best researchers in MCDA in the whole world. This means that the top minds in the field don’t take MCDA too “hard” on its supposed “perfection” as decision models.*



AN EXAMPLE: EVEN SWAPS

somewhat structured approach to
decision making, but with
some interesting limitations

EVEN SWAPS

- It is a simple technique to deal with problems involving several attributes that do not do well when trying to formally represent relationships and preferences.

- Scenario: A consultant needs to rent an office and 5 places are possible
- We want to optimize the results which means in some lines ***minimizing*** and in others ***maximizing***.

Information	a	b	c	d	e
Commute	45	25	20	25	30
Clients	50	80	70	85	75
Services	A	B	C	A	C
Size	800	700	500	950	700
Cost	1850	1700	1500	1900	1750

- We can work with these numbers but we can also transform this table in a **consequence table**.

EVEN SWAPS

- This is basically a ranking per attribute to each choice (1 – best; 5 – worst):

Information	*a*	*b*	*c*	*d*	*e*
Commute	45	25	20	25	30
Clients	50	80	70	85	75
Services	A	B	C	A	C
Size	800	700	500	950	700
Cost	1850	1700	1500	1900	1750

Information	*a*	*b*	*c*	*d*	*e*
Commute	5	2	1	2	4
Clients	5	2	4	1	3
Services	1	3	4	1	4
Size	2	3	5	1	3
Cost	4	2	1	5	2

  - **You cannot simply use arithmetic and sum the columns** (in this example it works but in other cases, it doesn't and it fails catastrophically).
  - These are **rankings, not numbers** – the numbers represent ordered categories not numbers themselves. You can't do math as in "taller" – "tall" and this is exactly the same.
  - We could used words instead ("lowest", "fairly low", etc.) but numbers are better to visualize.

EVEN SWAPS

- The first step we can use in eliminating choices is by **dominance**. Given two choices a and b, a dominates b if it is **as good or better in all dimensions**.
- In this scenario there is one case of **pure (full) dominance** ($b \rightarrow e$) but also, a close dominance ($d \rightarrow a$).
- Fully dominated options can be safely eliminated – in this case e.

Information	a	b	c	d	e
Commute	45	25	20	25	30
Clients	50	80	70	85	75
Services	A	B	C	A	C
Size	800	700	500	950	700
Cost	1850	1700	1500	1900	1750

Information	a	b	c	d	e
Commute	5	**2**	1	2	**4**
Clients	5	**2**	4	1	**3**
Services	1	**3**	4	1	**4**
Size	2	**3**	5	1	**3**
Cost	4	**2**	1	5	**2**

EVEN SWAPS

- Let's consider the case of the partial dominance $d \rightarrow a$.
- The only point a beats d is in the cost category, where there is a $ 50 difference.
  - Here the **ranking as number problem** is clearly seen: 4 to 5 is not a real distance (in this case it is a mere $50 in $1900).
  - In here we could use **practical dominance** – i.e., a mere $50 is no significant difference and we can eliminate a.

Information	a	b	c	d
Commute	45	25	20	25
Clients	50	80	70	85
Services	A	B	C	A
Size	800	700	500	950
Cost	**1850**	1700	1500	**1900**

Information	a	b	c	d
Commute	**3**	2	1	**2**
Clients	**4**	2	3	**1**
Services	**1**	2	3	**1**
Size	**2**	3	5	**1**
Cost	**3**	2	1	**4**

EVEN SWAPS

- We are down to 3 choices and now we finally get to do some swapping, as there is no more partial or pure dominance scenarios.
- Take the **commute information** – it is quite close across the options (25, 20, 25).
- We can “swap” or “trade” a bit of clients for commuting. Let’s say “if I have longer commutes, I’d like to have more clients”. **This value is discretionary and open to interpretation!**

Information	*b*	*c*	*c’*	*d*
Commute	**25**	**~~20~~ →**	**25**	**25**
Clients	**80**	**~~70~~ →**	**78**	**85**
Services	B	C	C	A
Size	700	500	500	950
Cost	1700	1500	1500	1900

Information	*b*	*c*	*c’*	*d*
Commute	2	1	2	2
Clients	2	4	4	1
Services	3	4	4	1
Size	3	5	5	1
Cost	2	1	1	5

- By doing so we can eliminate commuting from the board.
- But it also changes another line, where we “swapped” the loss of time for clients.
- We are not changing the real numbers themselves but we are tricking ourselves to compensate for these differences.

EVEN SWAPS

- In the last swap we did for only one choice. Now we are going to on two choices, **simultaneously**.
- Take **services** for example. Here we have three tiers (A, B, C) and could balance them out making it more comparable (B, B, B).
- Let’s swap the quality of services for cost, which is also comparable. We compensate the “downward” motion in a dimension with an “upward” motion in another (and vice-versa).
- Note that the decision of the degree in the compensation is up to the decision maker.

Information	***b***	***c’***	***c’’***	***d***	***d’***
Clients	80	78	78	85	85
Services	**B**	**~~C~~ →**	**B**	**~~A~~ →**	**B**
Size	700	500	500	950	950
Cost	**1700**	**~~1500~~ →**	**1700**	**~~1900~~ →**	**1800**

Information	***b***	***c’***	***c’’***	***d***	***d’***
Clients	2	3	3	1	1
Services	3	4	4	1	1
Size	2	3	3	1	1
Cost	2	1	2	3	3

EVEN SWAPS

- Now we go back to a pure dominance scenario ($b \rightarrow$ c'') and it is safe to eliminate the dominated choice (c'').

Information	*b*	*c''*	*d'*
Clients	**80**	**78**	85
Size	**700**	**500**	950
Cost	1700	1700	1800

Information	*b*	*c''*	*d'*
Clients	**2**	**3**	1
Size	**2**	**3**	1
Cost	2	2	3

EVEN SWAPS

- Now, we do not have a pure dominance scenario, we are forced to go back to swapping.
- We could swap **clients** for another line but we still wouldn't solve it as we would end up with each remaining information as winner in the rankings in on dimension.
- Let's swap size for cost, then!
- The values for swapping are discretionary, but we try to be fair.
- This is a situation that we need to be aware of decision biases in order to counter them.
- Now we can eliminate size as it is now the same across the line.

Information	***b***	***b'***	***d'***	***d'***
Clients	80	80	85	85
Size	**~~700~~ →**	**950**	950	950
Cost	**~~1700~~ →**	**1950**	1800	1800

Information	***b***	***b'***	***d'***	***d'***
Clients	2	2	1	1
Size	2	1	1	1
Cost	1	2	2	1

- Finally, we have a winner!
- We are back to pure dominance ($d' \rightarrow b'$)!

Information	*b'*	*d'*
Clients	80	85
Cost	1950	1800

Information	*b'*	*d'*
Clients	2	1
Cost	2	1

- **Yay! Now it is our turn to criticize the shortcomings of this method.**

- However, we can see in this procedure the rationale behind most MCDA methods.

FORMAL CONCEPTS

The basics of every MCDA method

MCDA FORMAL CONCEPTS

- **The basic components of an MCDA method are:**
  - **Alternative(s)**
  - **Criterion (criteria)**
  - **Decision process**

- By **alternative** we mean the **attributes/options/actions/scenarios** we have to decide upon (lots of variation in terms…).

- Depending on the purpose of the decision making, alternatives may be absent altogether – i.e., **alternatives are not a necessary condition for MCDA***.

- There is some variation in the way we call the alternative (especially in the data collection instruments, adapted to the understanding of the decision maker).

- **The concept of alternative does not, necessarily, mean a feasible, possible or prone to be implementable option**.
  - *Eg.: In future scenario planning, not all futures may happen or even be possible, but they are still part of a given model.*
  - *Eg.2: In developing a new car model, we may build "mental prototypes" based on non-existing technologies as a way to further R&D.*

- The concept of an alternative, in modelling terms, is unique, and it means that any two distinct alternatives are mutually exclusive, i.e., we cannot join them together in a single alternative. But as you can see in the example, this is not a hard rule and it is often violated.
    - *Eg.3: In choosing a car, a green Celta 2024 and a green Celta 2023 are either two distinct alternatives (i.e., we can make a clear distinction between them and even develop a preference one over the other), or we simply define green Celta and both become instances of an upper class. But in this case, we cannot consider the year as relevant information for the decision process.*

- For those who use object-oriented programming think of the analogy between a class and an instance.

- Either you compare two instances with their own peculiarities, or consider them part of one class, and the class becomes the unit of analysis.

- Either way, let us assume $\boldsymbol{A}$ **is the set of potential alternatives** (options, courses of action, scenarios, etc.).

- **The set of alternatives may not be fixed** (i.e., pre-determined) and may evolve along the decision-making process.

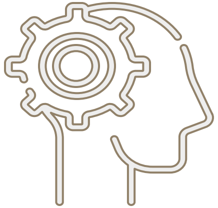
- Some methods:
    - Focus more on the process and the tying of preferences to alternatives is done separately or after the preferences, meaning adding or subtracting alternatives is usually OK;
    - In others, the decision process is done on top the the alternatives and therefore are less flexible to changing in the set A (and may not even allow it).
    - As such, one must pay attention to this before choosing a specific method.
    - We can compare the first approach to deduction (from theory to cases) and the second to induction (from cases to theory), in that the first does not need a "real" example, but the second is built from the examples.

- We define each alternative as a. Given that they are finite (there is an end to the list), let's say ($|A| = m$), we get the alternative set $A = \{a_1, a_2, \ldots, a_m\}$.

- If we model the alternatives by some variables $x_1, x_2, \ldots$ we can say that $a = (x_1, x_2, \ldots)$. However, if we have the same scores for two alternatives (a_1, a_2), they lose their concrete identity as a_1, a_2 become labels for something that is exactly the same underneath.

MCDA FORMAL CONCEPTS

- The second component are **criteria**.
- As we saw before, decision can be made based on one criterion alone, but if we do that we wouldn't be in this course.
- As in alternatives, there is a bit of variation in the terminology (criterion, attribute, feature, dimension, etc.).
- Take a criterion g.
- Any given criterion is a tool for evaluation or comparison of different alternatives.
- It measures the "performance" of a given g, denoted as $g(a)$.
- More often than not, $g(a)$ takes the form of a real number.
- If so, we could compare $g(a)$ and $g(b)$, and if $g(a) > g(b)$ we understand that the performance of the criterion g on the alternative a is higher / better / more preferable than the performance of the criterion g on the alternative b.



MCDA FORMAL CONCEPTS

- If this were a monocriterion decision, it would be safe to assume $a > b$ and therefore, a would be the best course of action.

- All the criteria within a decision could be defined as X_g.

- When comparing, we should be able to define an order ($<_g$) in X_g which gives us X_g: $(<_g, X_g)$:

  - Eg.: X_g is the set of possible values that the criterion g can take.
  - If we need to choose a cellphone and g represents "battery life" in hours, then X_g might be $\{2, 3, 6, 10, 12\}$ (possible battery durations)
  - $<_g$ represents a complete order (ranking) on X_g, meaning that every value in X_g can be compared to another, and these values can be ordered.
  - If battery life is the criterion, we can say 6 hours $<_g$ 8 hours, meaning 8 hours is preferred over 6, in terms of battery life.

MCDA FORMAL CONCEPTS

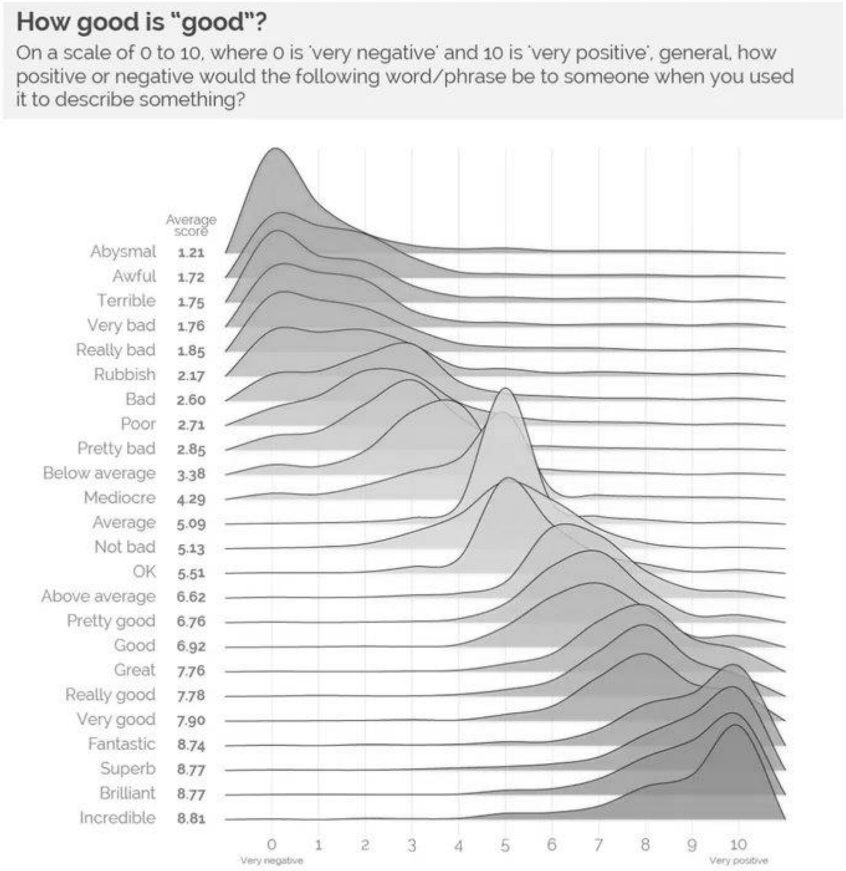
- These criteria can range in *degrees* or *scores* of the scale, defined as $x \ni X_g$.
- These degrees can be **numbers**, but also **verbal statements**.
- This means two main categories of scale will result (and an odd one):

- **1. Ordinal Scale (Qualitative Scale)**
- **What It Means**: The numbers or labels used in this scale do not indicate precise differences between options, only the order of preference.
- Two Subtypes:
  - **Verbal scale**: Uses words like poor, average, good, excellent to rank options, but the **gaps between them do not have a fixed meaning**.
  - **Numerical scale**: Uses numbers, but **the difference between values does not have a fixed interpretation** (e.g., 2 is better than 1, but not necessarily twice as good).

  - Eg.1: Hotel ratings (1-star, 2-star, 3-star, etc.) tell us the ranking but not how much better a 4-star hotel is than a 3-star hotel.
  - Eg.2: A Likert scale is exactly like that

MCDA FORMAL CONCEPTS

- Example of verbal descriptions and *actual* distributions



MCDA FORMAL CONCEPTS

- **2. Quantitative Scale**
- **What It Means**: Numbers used in this scale have a clear, measurable meaning, and the differences between values are meaningful and consistent.

- **Key Properties**:
- There is a zero point (e.g., a car with 0 horsepower has no power).
- The differences between values are proportional (e.g., a laptop with 8 hours of battery lasts twice as long as one with 4 hours).
  - Eg. : Measuring weight (10 kg is exactly twice as heavy as 5 kg), price, distance, or speed.

- **3. Intermediate or Mixed Scales**
- **What It Means**: In MCDA, scales are not always purely ordinal or purely quantitative.
  - Eg.: Interval scales (e.g., temperature in Celsius) where differences are meaningful, but the zero point is arbitrary.

MCDA FORMAL CONCEPTS

- In MCDA knowing the scale is essential because it alters reasoning and calculations.

- Because of the choice of scale in each method, the comparison between two criteria may be:

  - **Insufficiently precise** (concerning the complexity of the decision)
  - **Insufficiently reliable** (concerning consequences in the future)
  - We will see an example of that in one of papers

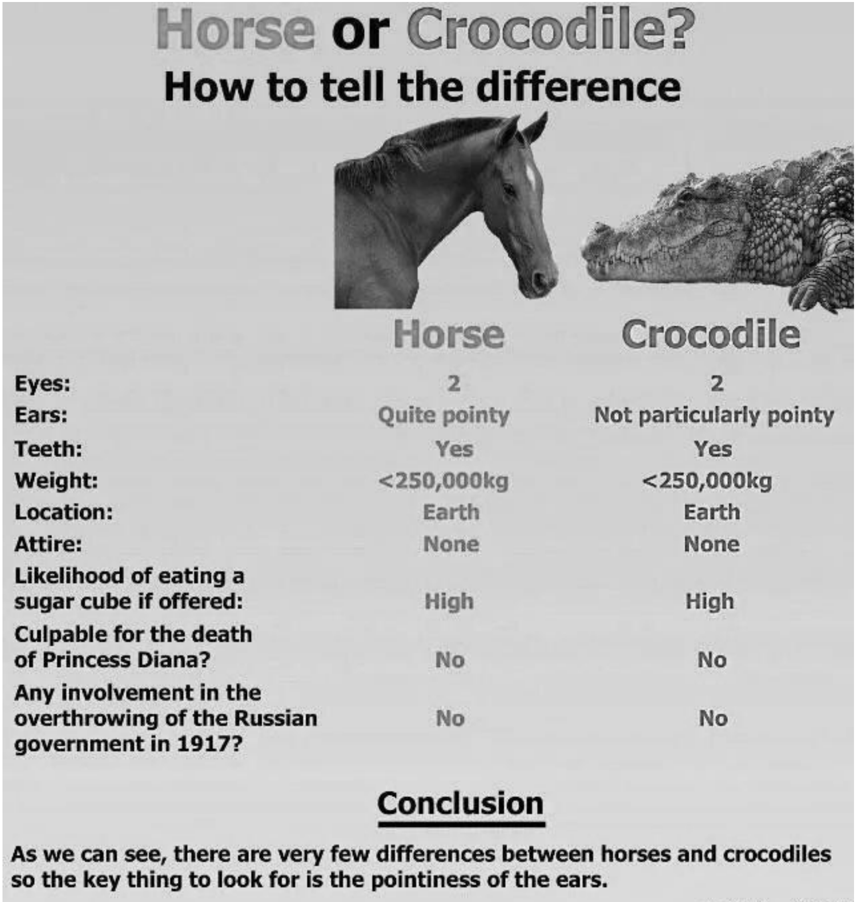
- As such, the first step in setting an MCDA model would be building n criteria, given that $n > 1$ (otherwise, it is a monocriterion decision).

- We could call this a family F of criteria. We need to ensure that F is adequate for our purposes:

  - Each criterion must be **sufficiently intelligible for each decision maker**.
  - Each criterion must be **perceived as relevant for comparing potential alternatives** (or at least be distinctive enough from the others).
  - Each criterion must be set in a way that **avoids prejudgment of values** (i.e., biasing)
  - The n criteria within the family F should be **coherent**, - i.e., satisfy logical requirements (**exhaustiveness**, **cohesiveness**, and **non redundancy**).
  - When possible, **parsimony** is needed as the models become too complex.
  - Dependence between criteria happens but depends on the methods.

MCDA
FORMAL CONCEPTS

- The following is a meme, but serves well to illustrate:



MCDA FORMAL CONCEPTS

- The third aspect is the **decision process** (using criteria and alternatives).
- “Decision process” is not exactly the best name because using an MCDA process does not have to end in a decision, therefore it would not be a decision process.
- As such **MCDA does not necessarily lead to solving problems**. Simpler uses of MCDA could include:
  - Drafting an appropriate set of A alternatives.
  - Setting a family F of criteria.
  - Checking whether some or all of $a \in A$
- That means **MCDA does not have to aim at prescribing or recommending** a course of action.
- There is also some variation in the nomenclature – decision process, decision making problem, problem formulation, objective eliciting, etc.
- **“Problematic”** is probably the term that best envisions what is the core of an MCDA process, but it is not widely used.
- Let us assume this “non- resolution” approach as a ***descriptive problematic*** $(P.\delta)$.

MCDA FORMAL CONCEPTS

- However, 3 other main problematics are more common in MCDA:

- The ***choice problematic*** $(P.\alpha)$
- Goal: selecting a small number of “good” alternatives, from which one alternative may be chosen. The goal is not the choosing of the “best” alternative (finding an optimum) per se.

- The **sorting problematic** $(P.\beta)$
- Goal: assigning each alternative to the most appropriate category. Categories do not have to be ordered.

- The **ranking problematic** $(P.\gamma)$
- Goal: ordering (partially or completely) all alternatives in A so that one a is on the top of the list.
  - *This one concentrates the most applications, research and development within MCDA nowadays and is the core of this course.*

MCDA FORMAL CONCEPTS

- **Comparing criteria**

- Assume $A = \{a, b\}$. A few relationships are possible:
  - $a > b$
  - $a < b$
  - $a \geq b$
  - $a \leq b$
  - $a \sim b$
  - $a \ ? \ b$

- Which means we have three main possibilities: **preference (strict or pure versus weak)**, **indifference**, or **incomparability**.

- In most methods, we can also gauge the **intensity or degree of preference**.

- Most frequently, we will use a process called **multicriteria aggregation procedure** (MCAP), which allows us to somewhat consolidate information towards a goal.

- Given that $g_1(a), \ldots, g_n(a)$ and $g_1(b), \ldots, g_n(b)$, an MCAP will somehow compare both alternatives using:
  - A logic of **aggregation**
  - Other inter-criterion and technical **parameters** (weights, scales, constraints, etc.).

- Two main approaches to consolidate information: ***synthesizing criterion*** and ***synthetizing preference relational system***.

- **Synthesizing criterion**
- There will be some rule that joins all $g_1(a), \ldots, g_n(a)$.
- These performances are assessed for all criteria, and they will almost often be assigned a numerical value $v(a)$ to each $a \in A$.
- This aggregation will result in a value for the whole alternative, taking into consideration the performances as in $v(a) = V[g_1(a), \ldots, g_n(a)]$.
- The mechanics of these aggregations will vary a lot depending on the method and approach, but in most cases, alternatives are possible to be ranked according to $v(a)$.
- This approach is the backbone of **Multi-Attribute Value/Utility Methods (MAVT/MAUT)** family of MCDA methods.
- Common methods within or related to this approach (examples):
  - AHP
  - MACBETH
  - TOPSIS
  - SMART
  - MAUT
  - MAVT

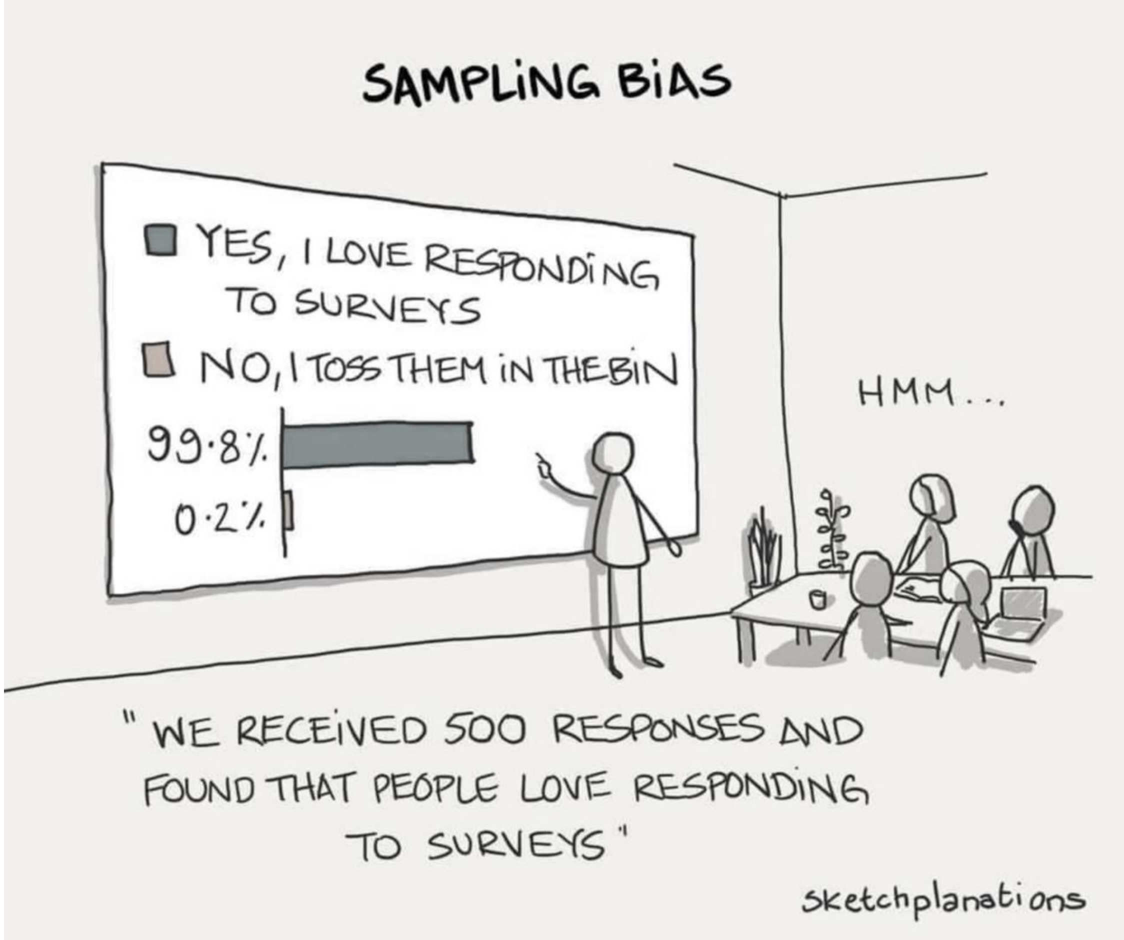
MCDA FORMAL CONCEPTS

- **Synthesizing preference relational system**
- In here, the MCAP does not compute the value of each $a \in A$ separately and then compare all elements $A = \{a, b, \dots, z\}$..
- In this approach, all elements within A are successively compared to each other.
- This means that in the former approach there is a **pre-ordering procedure** (evaluate all the performances in a, do the same for b and then compare both.
- Here we use pairwise comparison of alternatives as wholes, instead of breaking them down to components.
- However, this approach can lead to:
    - Intransitivities
    - Incomparability of certain pairs
    - Not converging to a recommendation
- This approach is best known as ***outranking methods***.
- Common methods within this approach (examples):
    - PROMETHEE
    - ELECTRE

MCDA FORMAL CONCEPTS

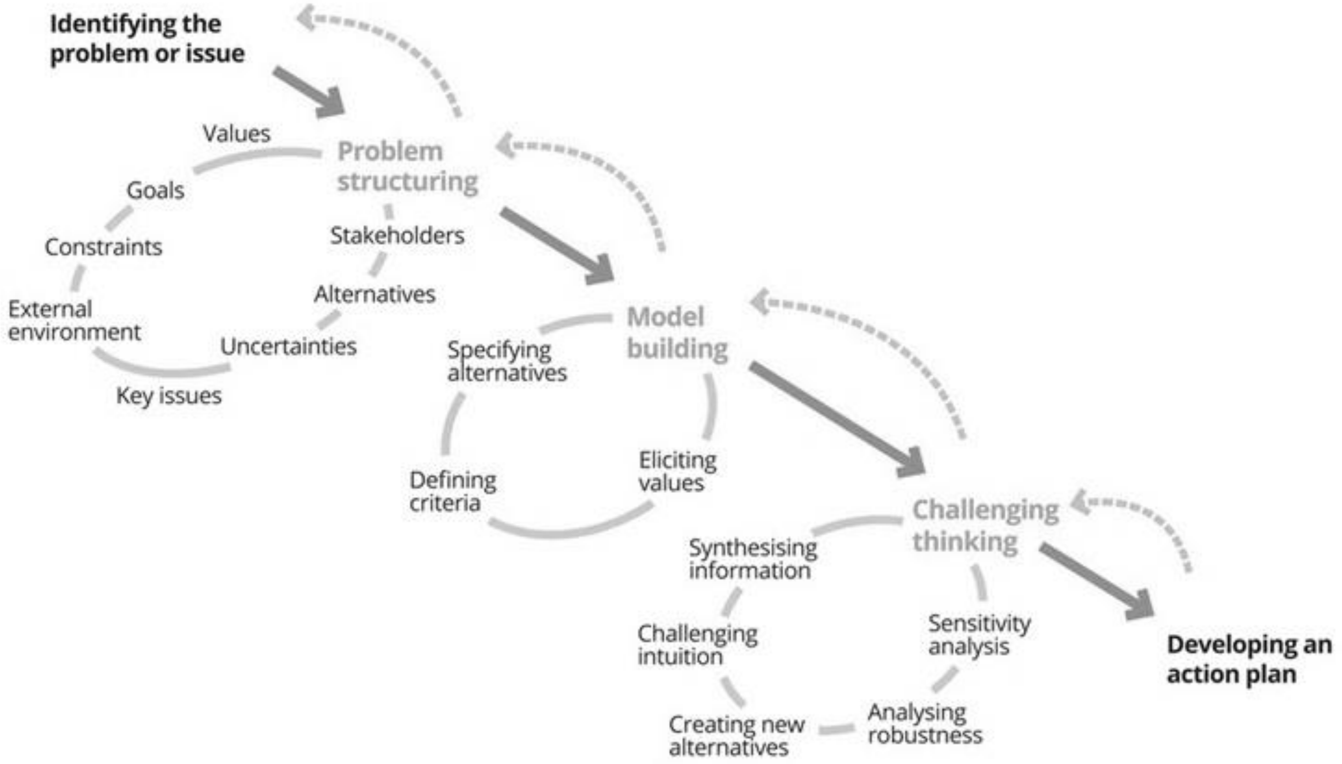
- **Decision makers**
- When choosing decision-makers for a Multi-Criteria Decision Analysis (MCDA) process, it's crucial to select individuals who:
  - have a **comprehensive understanding of the problem area**,
  - represent **diverse perspectives** from key stakeholders, and
  - are willing to **actively participate** in the decision-making process by providing their preferences and weighting criteria based on their **expertise and relevant knowledge**, **ensuring a well-rounded evaluation of all options** involved.
- Sampling: it is a problem!

MCDA
FORMAL CONCEPTS



MCDA FORMAL CONCEPTS

- Belton & Stewart (2002). Multiple Criteria Decision Analysis: An Integrated Approach, p. 6

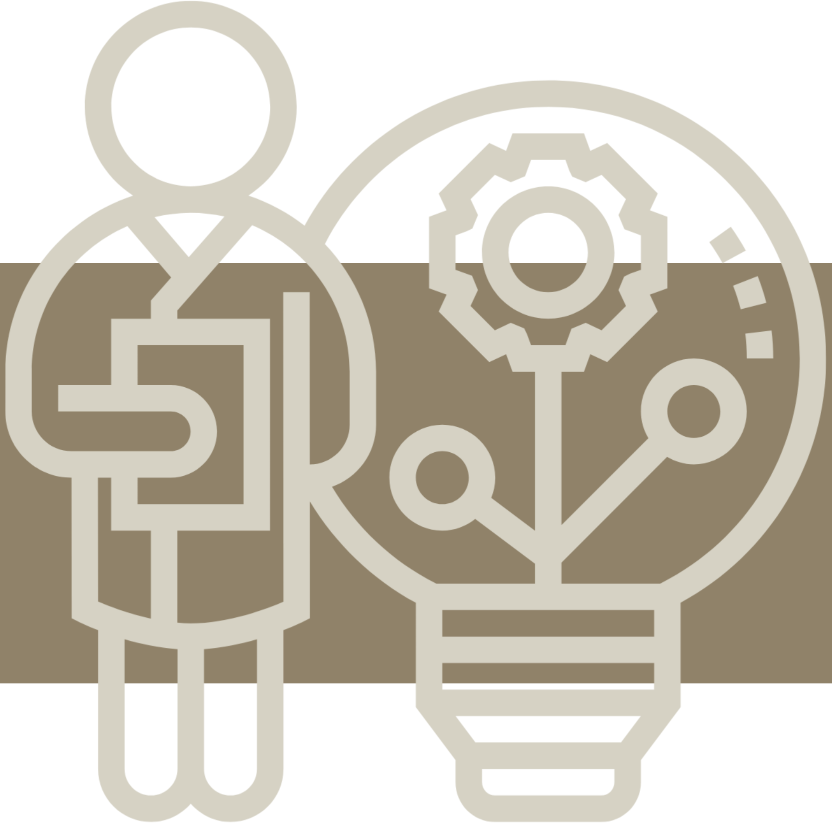


MCDA FORMAL CONCEPTS

- Forman & Selly (2001).

1. Plunging in	Gathering information and reaching conclusions without thinking about the crux of the issue or how decisions like this one should be made.
2. Frame blindness	Setting out to solve the wrong problem because your framework causes you to overlook attractive options or lose sight of important objectives.
3. Lack of frame control	Failing to define the problem in more ways than one, or being unduly influenced by the frames of others.
4. Overconfidence in your judgment	Failing to collect key factual information because of overconfidence in your assumptions and opinions.
5. Short-sighted shortcuts	Relying on ‘rules of thumb’ for crucial decisions, or on the most readily available information.
6. Shooting from the hip	Trying to keep straight in your head all the information relating to the decision rather than relying on a systematic procedure.
7. Group failure	Assuming that a group of smart people will automatically make a good decision even without a good decision process.
8. Fooling yourself about feedback	Failing to learn from evidence of past outcomes either because you are protecting your ego or because you are tricked by hindsight.
9. Not keeping track	Assuming that experience will make lessons available automatically.
10. Failure to audit your decision process	Failing to create an organized approach to understanding your own decision process.

RESEARCH EXAMPLES



A few examples of past papers using MCDA to help you plan your paper

RESEARCH EXAMPLES

- Example 1:

INDEPENDENT JOURNAL OF MANAGEMENT & PRODUCTION (IJM&P)
http://www.ijmp.jor.br v. 8, n. 4, October - December 2017
ISSN: 2236-269X
DOI: 10.14807/ijmp.v8i4.643

ORGANIZATIONAL CREATIVITY IN INNOVATION – A MULTICRITERIA DECISION ANALYSIS

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Accept: 24/04/2017

ABSTRACT

Creativity is essential for the emergence of innovation within organizations, both necessary for organizational survival. Several models have been proposed for organizational creativity, each containing different constructs. This research aims to verify the standardization of constructs in the literature and to verify the possible existence of two dimensions not previously explored: hierarchy between constructs (global importance) and weight of

RESEARCH EXAMPLES

- Example 2:

RELATOS DE PESQUISAS

PG&C

A FUZZY AHP ANALYSIS OF IT OUTSOURCING MONITORING IN PUBLIC ORGANIZATIONS

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Abstract
Current literature on information technology points to a scenario where resistance to change must be considered in all IT implementation processes. However, there is no consistency in the extant literature

RESEARCH EXAMPLES

- Example 3:

HOLOS
ISSN 1807 - 1600

RESISTANCE IN PROCESSES OF CHANGE IN INFORMATION TECHNOLOGY: A FUZZY AHP APPROACH

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DOI: 10.15628/holos.2021.10355

ABSTRACT

Current literature on information technology points to a scenario where resistance to change must be considered in all Information Technology (IT) implementation processes. However, there is no consistency in the extant literature about the interplay among the several triggers to resistance to change in IT. This paper aims at surveying the literature and investigating their roles in IT change management. Fuzzy AHP (Analytical Hierarchical Process) is used to provide greater flexibility in understanding the answers. The results point to two main sets of behaviours (intrinsic and extrinsic), which find support from other management fields. This paper contributes to the literature by showing that contrary to what was formerly believed, resistance to change in IT is not as much linked to technical aspects but to personal and team-level causes.

KEYWORDS: Resistance, Change, Information Technology, Fuzzy, Analytical Hierarchical Process.

RESEARCH EXAMPLES

- Example 4:

RAM
Revista de Administração Mackenzie
ISSN 1678-6971 (electronic version) • RAM, São Paulo, *24*(1), eRAMR230055, 2023
Resources and Entrepreneurial Development, https://doi.org/10.1590/1678-6971/eRAMR230055.en
Submitted: Mar. 8, 2021 | Approved: Mar. 8, 2022

A fuzzy AHP analysis of potential criteria for initiatives in digital transformation for agribusiness

Uma análise *fuzzy* AHP de critérios potenciais para iniciativas de transformação digital para o agronegócio

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Authors' notes

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TIMELINE

Subject to change

TODAY

MCDA formal concepts and examples

03

Analytical Hierarchical Process (AHP)

04

Fuzzy AHP and TOPSIS

05

MACBETH

PAPRIKA

Nothing to do with cooking, unfortunately

REFERENCES

REFERENCES

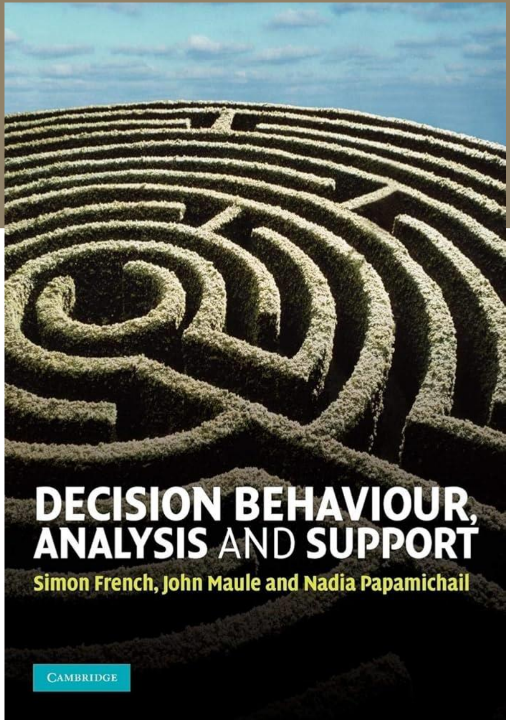
Today's content was mainly based on

- **Goodwin, P., & Wright, G. (2014). Decision analysis for management judgment. John Wiley & Sons. Belton, V., & Stewart, T. (2012). Multiple criteria decision analysis: an integrated approach. Springer Science & Business Media.**
- **Greco, S., Figueira, J., & Ehrgott, M. (Eds.). (2016). Multiple criteria decision analysis: state of the art surveys. New York, Springer.**
- **Forman, E. H., & Selly, M. A. (2001). Decision by objectives: how to convince others that you are right. World Scientific.**

RECOMMENDATION

This is an extra book that I highly recommend because it is in the intersection between decision theories and behavioral studies.

- **French, S., Maule, J., & Papamichail, N. (2009). Decision behaviour, analysis and support. Cambridge University Press.**



THANKS

Does anyone have any questions?
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