

INTRODUCTION TO MULTICRITERIA DECISION ANALYSIS (MCDA)

03 – Analytical Hierarchical Process (AHP)
Fellipe Martins



SNEAK PEEK



Today we are going to explore the most famous method in MCDA (probably) – the Analytical Hierarchical Process (AHP).

I hope you had time to read the corresponding materials, and let's dive in!

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Recap

- A is the set of alternatives ($A = \{a_1, a_2, \dots, a_m\}$).
- These alternatives can be analyzed through a set of orderable criteria $X_g: (<_g, X_g)$.
- Each criterion $g(a)$ may be used in a quantitative way to inform us about its importance
- Criteria can thus be compared - $g(a) > g(b)$.
- Comparisons can take many forms, according to each method (dominance): preference (strict or pure versus weak), indifference, or incomparability.
- In most methods, we can also gauge the intensity or degree of preference.
- Given that $g_1(a), \dots, g_n(a)$ and $g_1(b), \dots, g_n(b)$, a logic of aggregation will somehow compare both alternatives
- Other inter-criterion and technical parameters (weights, scales, constraints, etc.) can also be parts of the method.





ANALYTICAL HIERARCHICAL PROCESS (AHP)

the most popular guy in school



What does AHP stand for?

AHP stands for **Analytic Hierarchy Process**.

AHP is a structured decision-making method that helps compare multiple criteria and find the best option when there are conflicting factors.

As part of the Multi-Attribute family of MCDA methods, its goal is finding the best alternative within a set of alternatives, but not through optimal solutions based on mathematical constraints.



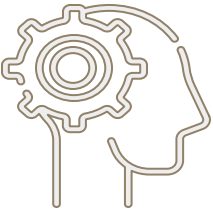


Is AHP a method?

- Yes, but also no.
- AHP in its pure, classic form is a method, but even the “original” AHP has two flavors (which we will explore in a bit).
- In addition, there is a lot of development and many, many alterations in the method.
- Think of it as a new boss who thinks she can better organize the company, until the next boss that introduces new changes, and so on.
- We are going to focus today on the classical forms of AHP.



AHP - STEP BY STEP

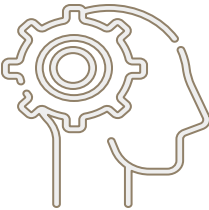


- Since AHP stands for Analytic Hierarchy Process, we need to imagine our problematic, set of criteria and set of alternatives in a hierarchical way.
- Our first goal is to think about an objective
- Let's give this a total weight of 1 – and therefore we will operate in smaller numbers (eg.: 0.34)

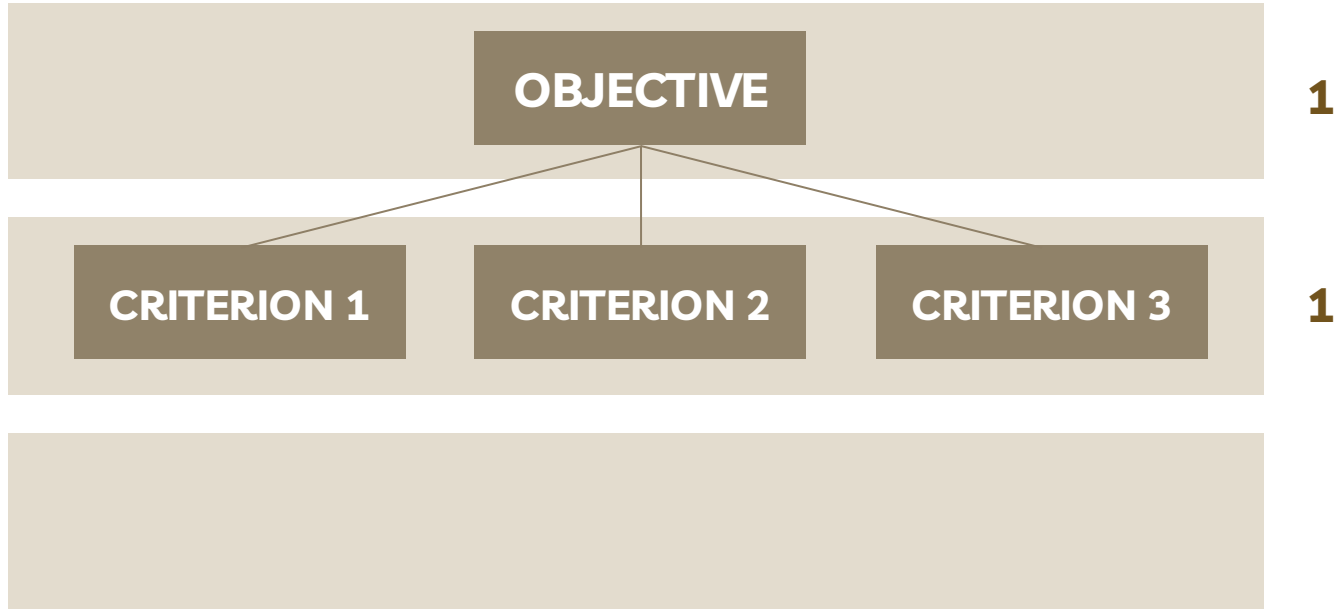
OBJECTIVE

1

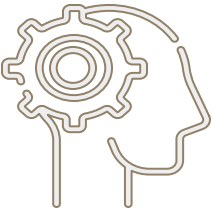
AHP - STEP BY STEP



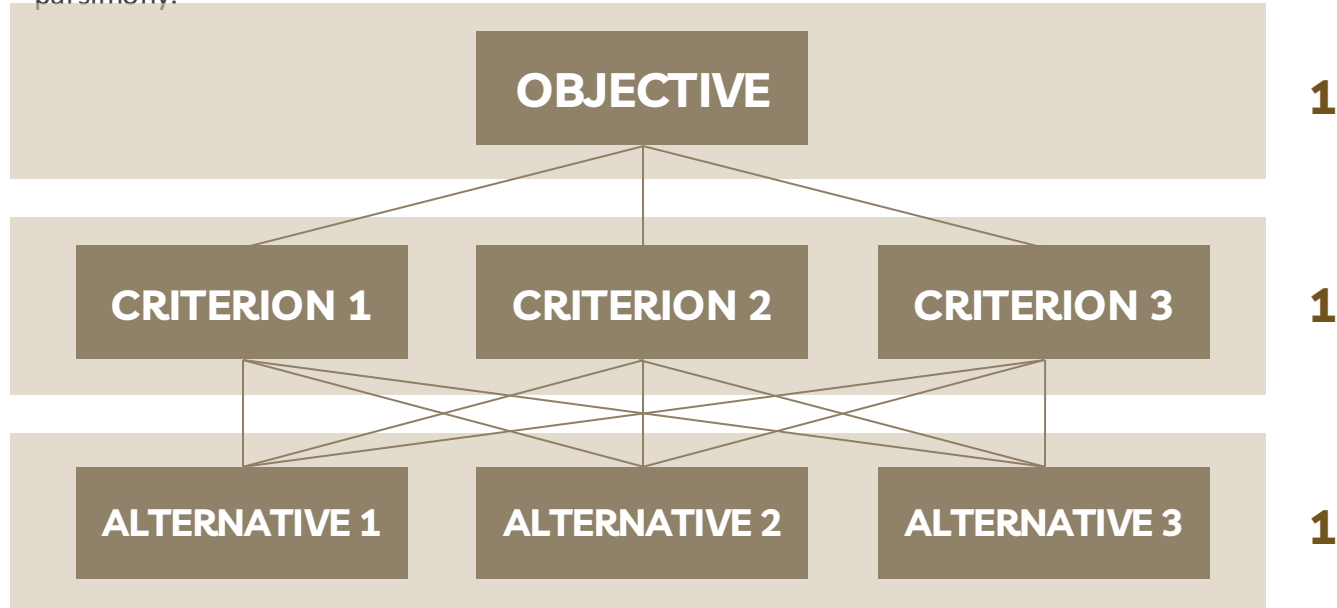
- We can now “break it down” into components (criteria, attributes, etc.)
- We could break criteria into sub-criteria but for now let’s focus on the core aspects of the method.
- Do you still remember the basic tenets we need to consider when choosing criteria?
- We will also give the second level a total of 1 point.



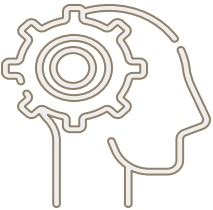
AHP - STEP BY STEP



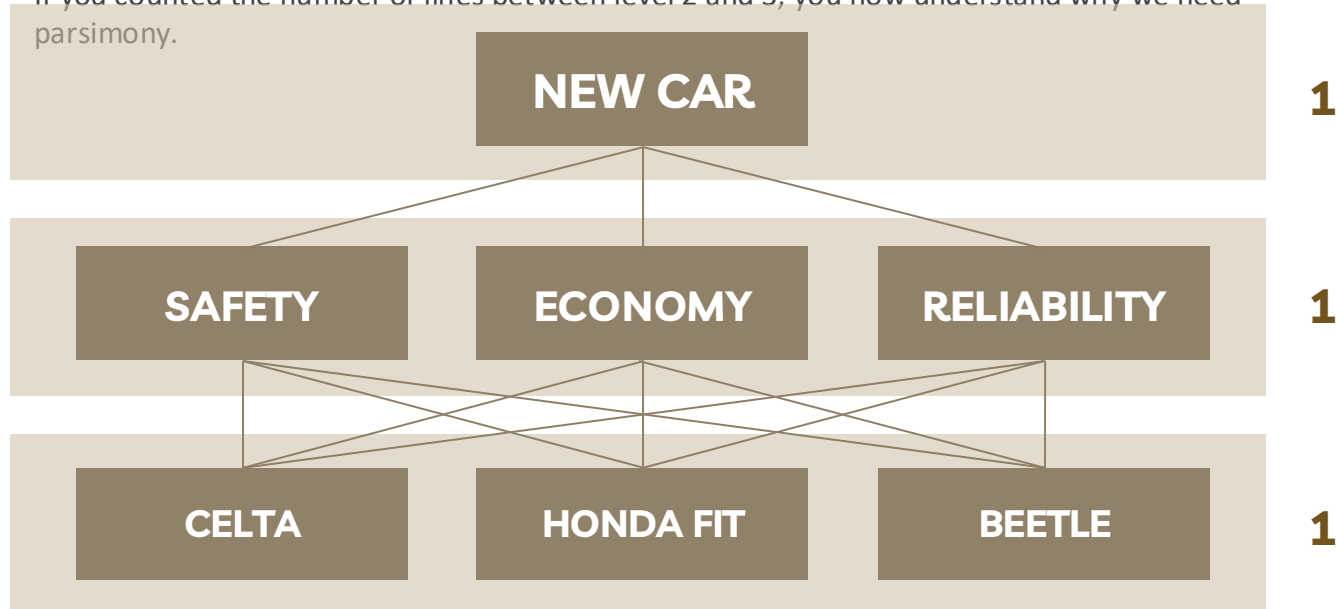
- In AHP alternatives are optional – i.e., since the model is hierarchical, we could stop at the second level.
- As you probably figured it out, the alternatives also receive a total of 1.
- If you counted the number of lines between level 2 and 3, you now understand why we need parsimony.



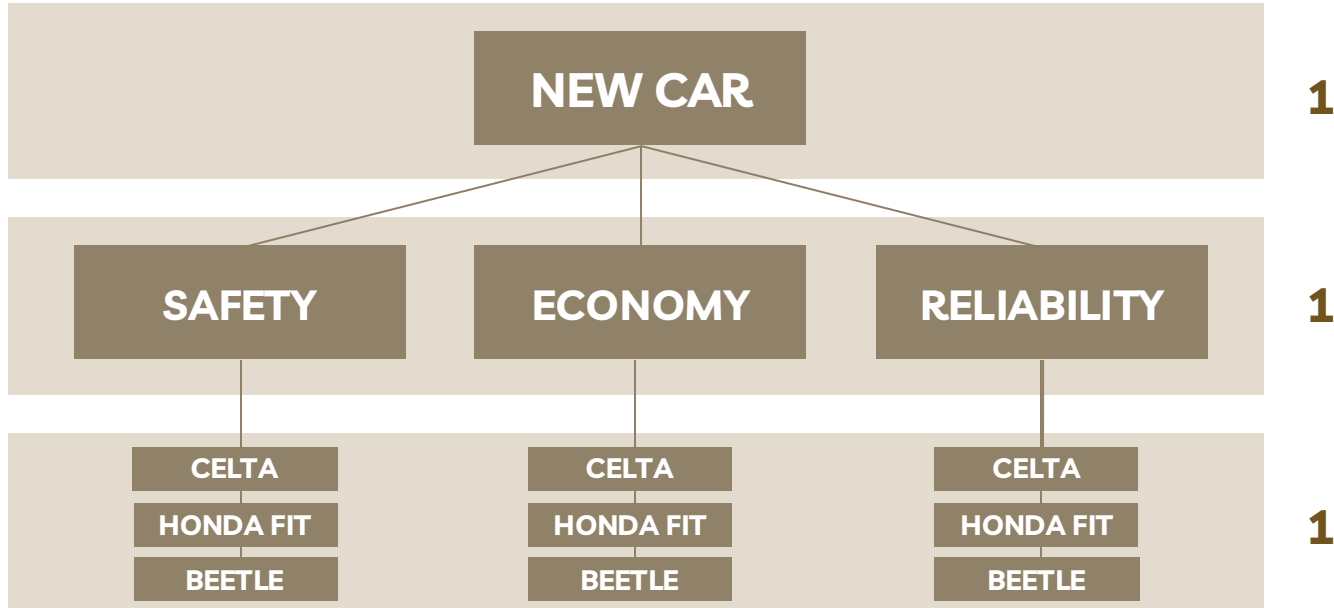
AHP - STEP BY STEP



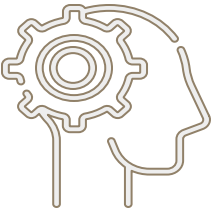
- In AHP alternatives are optional – i.e., since the model is hierarchical, we could stop at the second level.
- Also, in AHP there is no numerical difference between a criterion and an alternative.
- As you probably figured it out, the alternatives also receive a total of 1.
- If you counted the number of lines between level 2 and 3, you now understand why we need parsimony.



- You could also think about this in a different visualization:
- You will judge every alternative against every criterion and then aggregate this into one objective.



AHP - STEP BY STEP

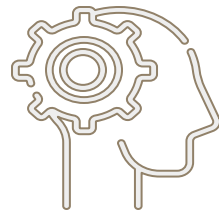




TWO WAYS

- AHP can be used with “**qualitative**” and “**quantitative**” data
- By “qualitative” data we mean using **verbal descriptors** – but these are transformed underneath to numerical scales
- By “quantitative” data we mean **real positive numbers** (discrete or continuous, normalized)
- In the end, we end up with a “scale” of numbers





SCALE (“QUALITATIVE”)

- In AHP, we need to **compare two alternatives by breaking them down to criteria**.
- The comparison is not done by alternatives (as in the outranking methods), but rather indirectly by **pre-ordering the importance or weight of each criterion**.
- To do so, we **compare criteria in a pairwise procedure** (one against the other, hence the parsimony in the model).
- Let’s assume we have a set of alternatives $A = \{a, b\}$.
- Let’s imagine a monocriterion decision based on $g(x)$.
- Since $g(x)$ is inherently a quantitative relationship, we need to transition from “perception” or “judgement” to this numerical ratio.
- Saaty (the author of AHP) developed a “scale” that can be used to do this:

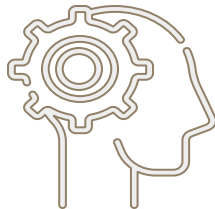
Intensity of importance	Definition
1	Equal importance
3	Somewhat more important
5	Much more important
7	Very much more important
9	Absolutely more important
2, 4, 6, 8	Intermediate values

SCALE

- Observe that **we cannot have values lower than 1** – because it is axiomatically impossible to be “more equal” than “equal”.
- In the same way, **we cannot have values higher than 9** – because it is impossible for an option to be more than absolutely important (hence, the meaning of “absolute”).
- Intermediate values are used when decision-makers (DMs) need more granularity – and we could even use even more fine-grained distinctions (2.5, 7.893, etc), *albeit it comes with a lot of criticism*.

Intensity of importance	Definition
1	Equal importance
3	Somewhat more important
5	Much more important
7	Very much more important
9	Absolutely more important
2, 4, 6, 8	Intermediate values

- By defining a ratio between two criteria or alternatives (since in AHP an alternative and criterion are the same – only the alternative is the bottom level of the hierarchical architecture), the reciprocal is also valid:
- Eg.: Given two criteria a and b , and if a is $2 \times b$, how much is 1 b in comparison to a ? And a to a ?

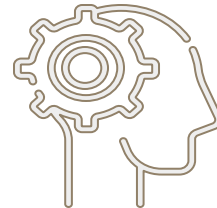


SCALE

- As such, we can define the basic properties of an AHP judgement matrix as:
- 1. A matrix with at least two criteria (otherwise it is a monocriterion decision and no MCDA is needed).
- 2. The principal diagonal must always be 1 (as in $1a = 1a$, $1b = 1b$, etc.).
- 3. For each judgement n the reciprocal must be $1/n$.

$$\begin{matrix} & a & b & c \\ a & 1 & 2 & 4 \\ b & ? & 1 & 3 \\ c & ? & ? & 1 \end{matrix} \rightarrow \begin{matrix} & a & b & c \\ a & 1 & 2 & 1/4 \\ b & 1/2 & 1 & 1/3 \\ c & 4 & 1/3 & 1 \end{matrix}$$

Intensity of importance	Definition
1	Equal importance
3	Somewhat more important
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7	Very much more important
9	Absolutely more important
2, 4, 6, 8	Intermediate values





TWO MORE WAYS

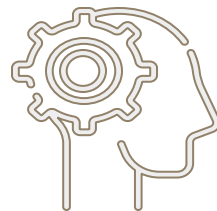
- The classical AHP uses the **approximate eigenvector method**
- A common alternative is using **means** (geometric, fuzzy geometric, etc)
- Let's start with the classic one



APPROXIMATE EIGENVECTOR

APPROXIMATE EIGENVECTOR

- Instead of solving for the eigenvector using direct eigenvalue decomposition, we **square the pairwise comparison matrix repeatedly**. This **iteratively amplifies the dominant eigenvector**, which **stabilizes as the priority weights**.
- 1. Start with the Pairwise Comparison Matrix A .
 - Multiply A by itself (square it: A^2).
 - Normalize the rows (optional, for faster convergence).
- 2. Extract the Dominant Eigenvector
 - Take the sum of each row.
 - Normalize the vector by dividing each element by the sum of all elements.
- 3. Repeat Squaring Until Convergence
 - Square the matrix again.
 - Extract the new eigenvector.
 - Continue until the eigenvector stabilizes (i.e., the values do not change up to 4 decimal places).



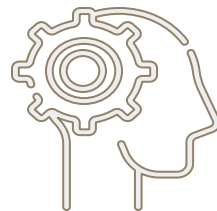
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- **Example: Choosing the Best Laptop (MacBook, Acer, Chromebook)**
- **Step 1: Define the Pairwise Comparison Matrix**
- We use five criteria:
 - 1. Battery Life (BL)
 - 2. Performance (PF)
 - 3. Price (PR)
 - 4. Durability (DU)
 - 5. Resale Value (RV)
- Pairwise comparison matrix (A) based on expert judgment:

$$A = \begin{bmatrix} 1 & 3 & 5 & 2 & 4 \\ 1/3 & 1 & 4 & 1/2 & 3 \\ 1/5 & 1/4 & 1 & 1/6 & 1/2 \\ 1/2 & 2 & 6 & 1 & 5 \\ 1/4 & 1/3 & 2 & 1/5 & 1 \end{bmatrix}$$

- Each value in row i , column j represents how much more important criterion i is compared to criterion j .



APPROXIMATE EIGENVECTOR

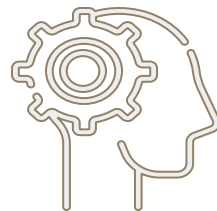
APPROXIMATE EIGENVECTOR

- **Step 2 – Square the matrix (A^2)**
- We compute $A^2 = A \times A$.

$$A^2 = \begin{bmatrix} 1 & 3 & 5 & 2 & 4 \\ 1/3 & 1 & 4 & 1/2 & 3 \\ 1/5 & 1/4 & 1 & 1/6 & 1/2 \\ 1/2 & 2 & 6 & 1 & 5 \\ 1/4 & 1/3 & 2 & 1/5 & 1 \end{bmatrix} \times \begin{bmatrix} 1 & 3 & 5 & 2 & 4 \\ 1/3 & 1 & 4 & 1/2 & 3 \\ 1/5 & 1/4 & 1 & 1/6 & 1/2 \\ 1/2 & 2 & 6 & 1 & 5 \\ 1/4 & 1/3 & 2 & 1/5 & 1 \end{bmatrix}$$

- This results in:

$$A^2 = \begin{bmatrix} 3.15 & 10.08 & 29.2 & 4.89 & 18.9 \\ 1.08 & 3.52 & 10.88 & 1.8 & 7.18 \\ 0.33 & 1.09 & 3.45 & 0.58 & 2.19 \\ 1.85 & 6.0 & 18.22 & 3.12 & 11.75 \\ 0.58 & 1.88 & 5.72 & 0.97 & 3.68 \end{bmatrix}$$



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APPROXIMATE EIGENVECTOR

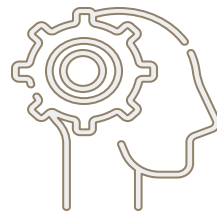
- Step 3 – Extract the Priority Vector (Eigenvector)
- Sum each row.

$$A^2 = \begin{bmatrix} 3.15 & 10.08 & 29.2 & 4.89 & 18.9 \\ 1.08 & 3.52 & 10.88 & 1.8 & 7.18 \\ 0.33 & 1.09 & 3.45 & 0.58 & 2.19 \\ 1.85 & 6.0 & 18.22 & 3.12 & 11.75 \\ 0.58 & 1.88 & 5.72 & 0.97 & 3.68 \end{bmatrix} \quad S = \begin{bmatrix} 66.22 \\ 24.46 \\ 7.64 \\ 40.94 \\ 12.83 \end{bmatrix}$$

- Normalize by dividing each row sum by the total sum: $X_{\text{normalized},i} = \frac{X_i}{\sum X}$

$$w = \begin{bmatrix} \frac{66.22}{152.09} \\ \frac{24.46}{152.09} \\ \frac{7.64}{152.09} \\ \frac{40.94}{152.09} \\ \frac{12.83}{152.09} \end{bmatrix} \quad w = \begin{bmatrix} 0.43 \\ 0.16 \\ 0.05 \\ 0.27 \\ 0.09 \end{bmatrix}$$

- This is the **priority vector** after the first squaring.



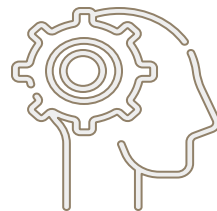
APPROXIMATE EIGENVECTOR

APPROXIMATE EIGENVECTOR

- **Step 4 - Repeat Squaring Until Convergence**
- Square the matrix again: $A^4 = A^2 \times A^2$.
 - Extract the new eigenvector.
 - Iterate until the values stabilize up to 4 decimal places.
- After further squaring, the final eigenvector stabilizes at:

$$w = \begin{bmatrix} 0.39 \\ 0.17 \\ 0.05 \\ 0.29 \\ 0.10 \end{bmatrix}$$

- This means:
 - Battery Life (0.39) is the most important
 - Durability (0.29) is the second most important
 - Performance (0.17) is moderately important
 - Resale Value (0.10) matters somewhat
 - Price (0.05) is the least important

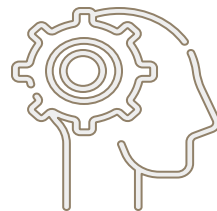


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APPROXIMATE EIGENVECTOR

Overview

- **1. We started with a comparison matrix**, where we rated how important each criterion was relative to the others.
 - **2. We squared the matrix multiple times**, amplifying the dominant eigenvector.
 - **3. After repeated squaring, the priority weights stabilized**, giving us the relative importance of each criterion.
 - **4. These weights tell us what matters most** in choosing the best laptop.
-
- The original method uses eigenvalue calculation which is more precise, but computationally more expensive (lots of software options use it).
 - For a classroom example or cases where the highest precision is not needed, we can use this approximate procedure (matrix squaring).



APPROXIMATE EIGENVECTOR

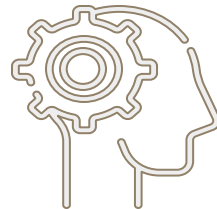
APPROXIMATE EIGENVECTOR

- Now let's use this to evaluate the alternatives.
- We should to the same pairwise procedure criterion × criterion for each alternative (and do the same matrix squaring / eigenvector convergence)

Macbook	<i>Battery life</i>	<i>Performance</i>	<i>Price</i>	<i>Durability</i>	<i>Resale value</i>
<i>Battery life</i>	1				
<i>Performance</i>		1			
<i>Price</i>			1		
<i>Durability</i>				1	
<i>Resale value</i>					1

- But, for the sake of simplification here is a provided table with weights for all criteria × alternatives

Option / Crit	<i>Battery life</i>	<i>Performance</i>	<i>Price</i>	<i>Durability</i>	<i>Resale value</i>
<i>Macbook</i>	9	9	3	8	9
<i>Acer</i>	6	6	7	6	5
<i>Chromebook</i>	4	3	9	2	3



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- Since we already have the weights of the criteria and now the weights...

Weight	0.39	0.17	0.05	0.25	0.10
Option / Crit	Battery life	Performance	Price	Durability	Resale value
Macbook	9	9	3	8	9
Acer	6	6	7	6	5
Chromebook	4	3	9	2	3

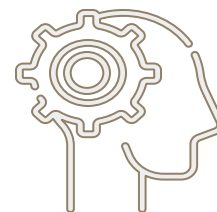
- ... we obtain the final scores (multiplying by priority weights):

$$\text{MacBook Score} = (9 \times 0.39) + (9 \times 0.17) + (3 \times 0.05) + (8 \times 0.29) + (9 \times 0.10) = 8.41$$

$$\text{Acer Score} = (6 \times 0.39) + (6 \times 0.17) + (7 \times 0.05) + (6 \times 0.29) + (5 \times 0.10) = 5.95$$

$$\text{Chromebook Score} = (4 \times 0.39) + (3 \times 0.17) + (9 \times 0.05) + (2 \times 0.29) + (3 \times 0.10) = 3.40$$

- **MacBook wins with 8.41 points**, making it the best choice.



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- What about “quantitative” data?
- In AHP, **quantitative criteria** can be **directly normalized** instead of **requiring pairwise comparisons**.
- Example – evaluate the best car using safety, reliability, and **economy** (km/l expenditure).
- For the first two criteria we use the Saaty Scale (1-9, reciprocals).
- For economy we obtain the real quantitative data

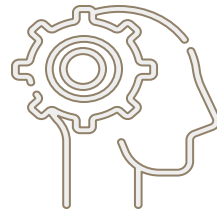
Car model	km/l
Celta	7.6
Honda Fit	11.8
Beetle	8

- And we normalize as before:

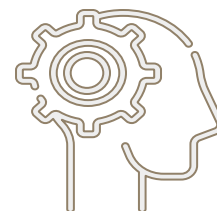
$$\text{Celta} = \frac{7.6000}{27.4000} = 0.2774$$

$$\text{Honda Fit} = \frac{11.8000}{27.4000} = 0.4307$$

$$\text{Beetle} = \frac{8.0000}{27.4000} = 0.2920$$



APPROXIMATE EIGENVECTOR



APPROXIMATE EIGENVECTOR

- Now, let's do an example in Google Sheets:

AHP

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Default...

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N13

	A	B	C	D	E	F	G	H	I	J	K									
1	AHP - Version 1 (a.k.a. "Eigenvector method")																			
2																				
3	1 - Trade-offs between criteria																			
4																				
5		Safety	Economy	Reliability																
6	Safety	1.00	9.00	7.00																
7	Economy	0.11	1.00	0.33																
8	Reliability	0.14	3.00	1.00																
9																				
10	2 - Squaring the matrix																			
11																				
12		Safety	Economy	Reliability																
13	Safety	3.00	39.00	17.00																
14	Economy	0.27	3.00	1.44																
15	Reliability	0.62	7.29	3.00																
16																				
17	2.1 Add the lines to obtain eigenvector / normalize eigenvector																			
18																				
19		Safety	Economy	Reliability	Eigenvector	Normalized Eig.														
20	Safety	3.00	39.00	17.00	59.00	0.7907														
21	Economy	0.27	3.00	1.44	4.71	0.0632														
22	Reliability	0.62	7.29	3.00	10.90	0.1461														
23					74.62															
24																				
25	2.2 Square the matrix and repeat the process - check if the new eigenvector converges to 4 decimal places																			
26																				
27		Safety	Economy	Reliability	Eigenvector	Normalized Eig.														
28	Safety	30.048	357.857	158.333	546.238	7.320	0.791													
29	Economy	2.513	30.048	13.254	45.815	0.614	0.063													
30	Reliability	5.680	67.857	30.048	103.585	1.388	0.146													
31					695.638															



MEAN METHOD

- In this version, we use a more simplified procedure based on means (I will provide an example with geometric means).
- 1. Start with the Pairwise Comparison Matrix A , as before.
- 2. Extract the (geometric) means of each row.
 - For each criterion, calculate:

$$GM_i = \left(\prod_{j=1}^n a_{ij} \right)^{1/n}$$

- where a_{ij} is the pairwise comparison value for row i and column j , and n is the number of criteria.

$$GM_{Price} = (1 \times 1/3 \times 1/5)^{1/3} = (1/15)^{1/3} = 0.27$$

$$GM_{Battery} = (3 \times 1 \times 1/2)^{1/3} = (3/2)^{1/3} = 0.89$$

$$GM_{Performance} = (5 \times 2 \times 1)^{1/3} = (10)^{1/3} = 2.15$$

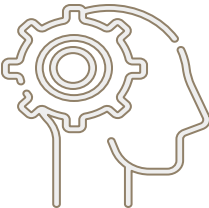
- 3. Normalize, as before:

$$w_{Price} = \frac{0.27}{(0.27 + 0.89 + 2.15)} = 0.08$$

$$w_{Battery} = \frac{0.89}{(0.27 + 0.89 + 2.15)} = 0.26$$

$$w_{Performance} = \frac{2.15}{(0.27 + 0.89 + 2.15)} = 0.66$$

- 4. As before, multiply alternative scores by these weights to determine the best choice.

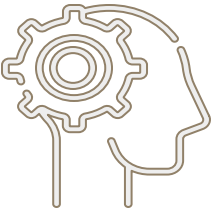


MEAN METHOD

MEAN METHOD

Overview

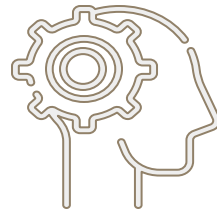
- 1. We started with a **comparison matrix**, where we rated how important each criterion was relative to the others.
 - 2. We computed the **geometric means of rows and normalized**, obtaining a ratio value.
 - 4. These weights tell us **what matters most** in choosing the best car.
-
- There is some room for experimentation here (some variants use other simple average instead of geometric means, for instance).



MEAN METHOD

- Now, let's do an example in Google Sheets (I already pre-made all formulae):

AHP							
File Edit View Insert Format Data Tools Extensions Help							
Menus							
100% 123 Calibri 11							
S10							
	A	B	C	D	E	F	G
1							
2			1	2	3	4	5
3		Description	A	B	C	D	E
4	1	A	1.0000	2.0000	4.0000		
5	2	B	0.5000	1.0000	2.5000		
6	3	C	0.2500	0.4000	1.0000		
7	4	D					
8	5	E					
9	6	F					
10	7	G					
11	8	H					
12	9	I					
13	10	J					
14	11	K					
15	12	L					
16	13	M					
17	14	N					
18	15	O					
19		SUM	1.750	3.400	7.500		
20							
21							
22							
23			1	2	3	4	5
24		Description	A	B	C	D	E
25	1	A	0.5714	0.5882	0.5333		
26	2	B	0.2857	0.2941	0.3333		
27	3	C	0.1429	0.1176	0.1333		
28	4	D					
29	5	E					
30	6	F					
31	7	G					



MEAN METHOD

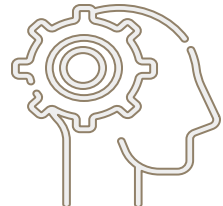


Tutorial

SUPER DECISIONS TUTORIAL

Automating it all in a simple
yet useful software

SUPERDECISIONS



SuperDecisions

- Free software to use in AHP / ANP models
- Login / subscribe → create account
- After login → Downloads
- Today we are following the first tutorial for **version V3.X**

The screenshot displays the SuperDecisions website interface. At the top, there's a navigation bar with links: HOME, THEORY, DOWNLOADS, MANUALS, TUTORIALS, SAMPLE MODELS, BUGS & SUPPORT, and ABOUT. Below the navigation bar, there's a section titled "The SuperDecisions is decision support software that implements the AHP and ANP." followed by a description of the Analytic Hierarchical Process (AHP) and the Analytic Network Process (ANP). A video player is embedded, showing the "SuperDecisions V3.2 Overview" video. To the right of the video player, there are several promotional boxes: "SuperDecisions" (Learn More), "Are you satisfied by your Job?" (Learn More), "Support AHP Vision!" (Donate, Learn More), "T.L. Saaty Videos" (Learn More), and "The CDF Organizations".

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SUPER DECISIONS CDF

HOME THEORY DOWNLOADS MANUALS TUTORIALS SAMPLE MODELS BUGS & SUPPORT ABOUT

The **SuperDecisions** is decision support software that implements the AHP and ANP.

The **Analytic Hierarchical Process (AHP)** and the **Analytic Network Process (ANP)** make it possible to include **intangibles** in decision making.

AHP/ANP are the most powerful synthesis methodologies for combining judgment and data to effectively rank options and predict outcomes.

SuperDecisions V3.2 Overview

Watch later Share

SuperDecisions V3.2 Overview

Watch on YouTube © 2019 Creative Decisions Foundation

SuperDecisions

SuperDecisions is decision making software based on the Analytic Hierarchy Process (AHP) and the Analytic Network Process (ANP). Decision making is all about setting priorities and the AHP and ANP, award-winning decision processes are the way to do that.

LEARN MORE

Are you satisfied by your Job?

Check out an interactive survey to find out how satisfied you are by your current job position. Using an AHP Ratings model, you can enter a few judgments and find out how close is your current job to your ideal job position. Use the survey to define the profile of your ideal job before getting out to the work market.

LEARN MORE

Support AHP Vision!

The SuperDecisions software is developed with the support of Creative Decisions Foundation, and the contributions of AHP and ANP practitioners like you.

Donate

LEARN MORE

T.L. Saaty Videos

Check out our new original videos of Thomas L. Saaty explaining the AHP and ANP methods. This material has never been published before and it provides valuable insights on how AHP/ANP were conceived as explained by Thomas L. Saaty himself.

LEARN MORE

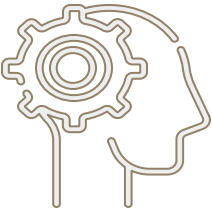
The CDF Organizations

CREATIVE DECISIONS

Recent News / Upcoming Events

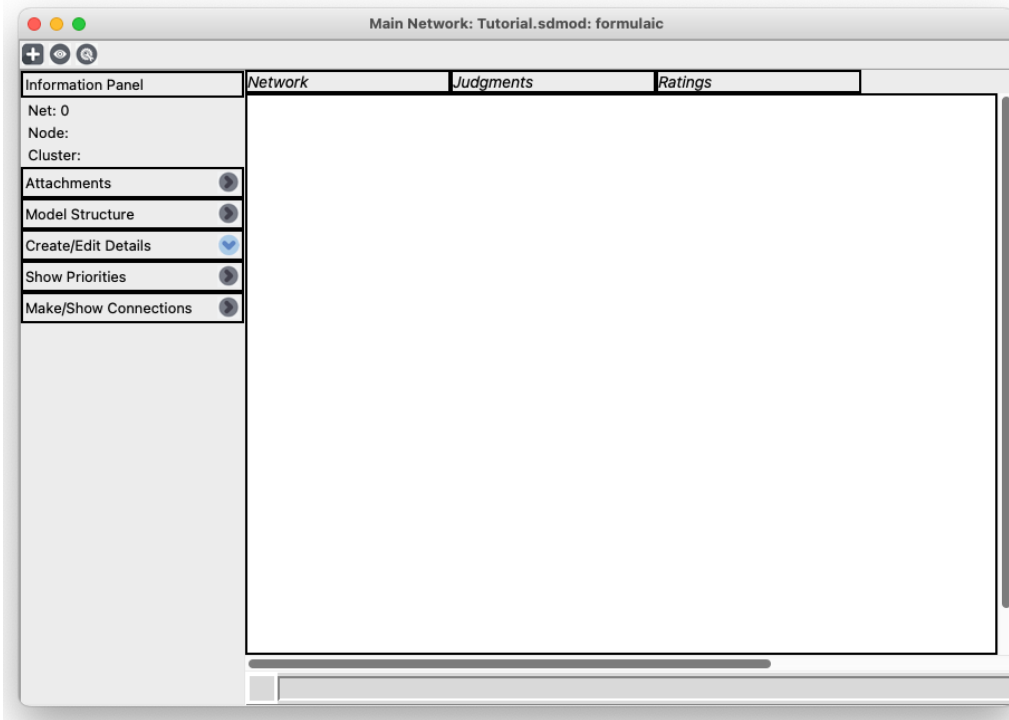
More resources for personal AHP workshop

SUPERDECISIONS



SuperDecisions 01

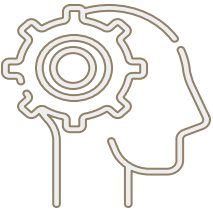
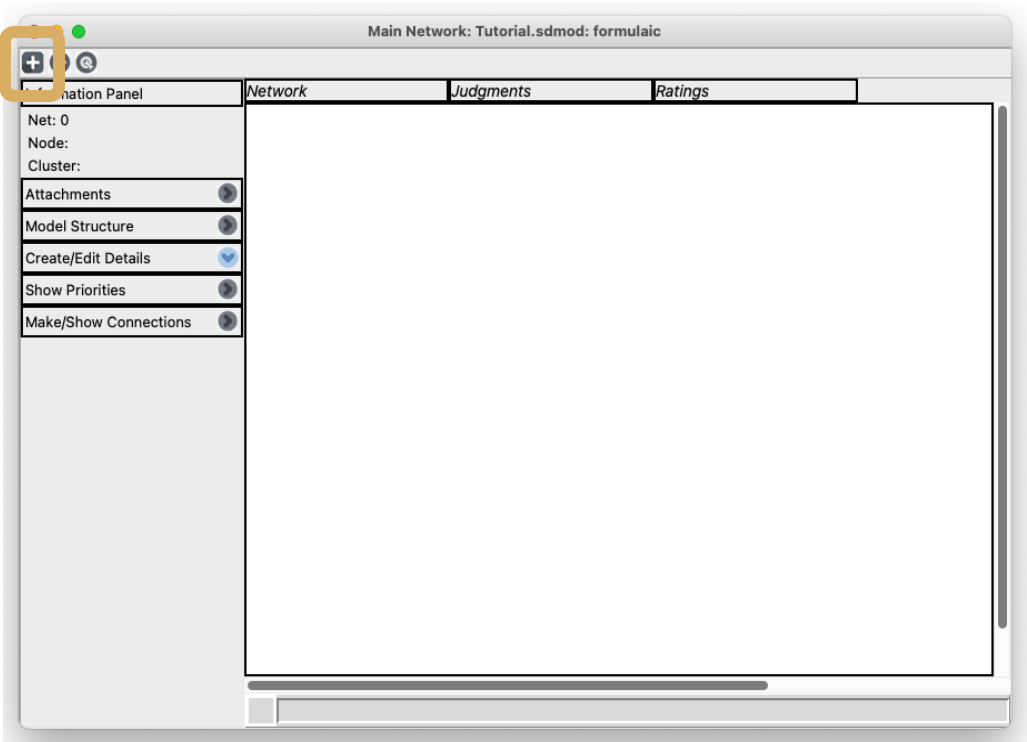
- Open SuperDecisions
- **Menu file → New; Save the new model with a name / folder**
- **Suggestion:** create a folder for the course and save your models there.



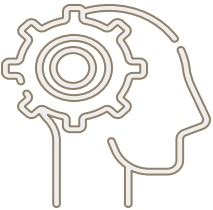
SUPERDECISIONS

SuperDecisions 02

- We start by creating nodes – nodes in SuperDecisions are levels in an AHP model

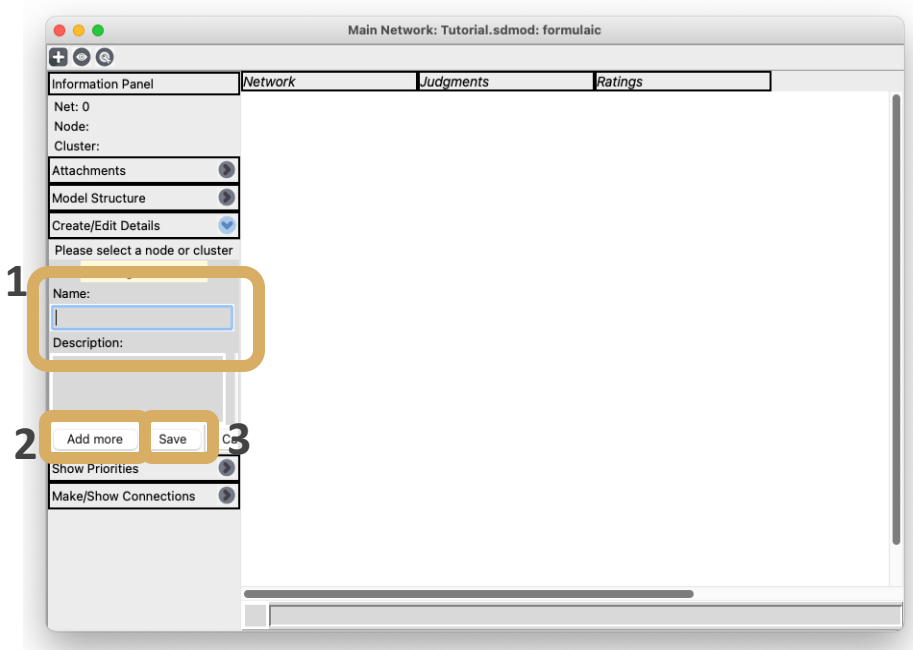


SUPERDECISIONS

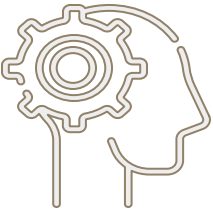


SuperDecisions 03

- We start by creating nodes – nodes in SuperDecisions are levels in an AHP model
- Name your nodes (1) and to create other nodes use “add more” (2), or save (3).
- Tip: Add numbers to nodes as SuperDecisions is very bad at ordering nodes / alternatives.
- **Eg.: 1Goal; 2Criteria; 3Alternatives**

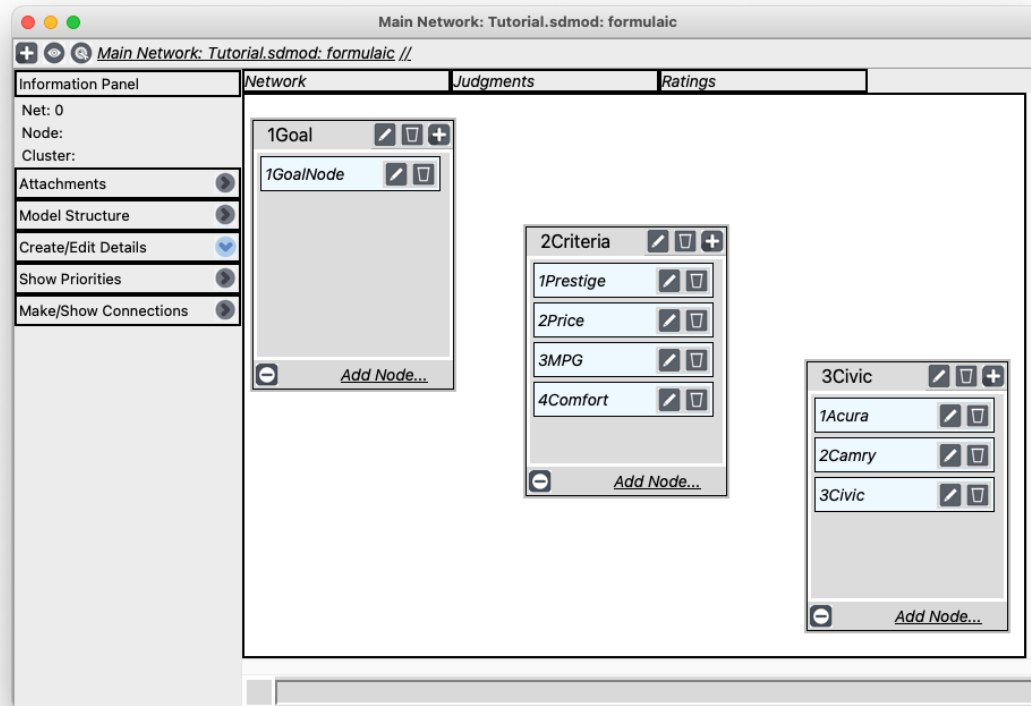


SUPERDECISIONS

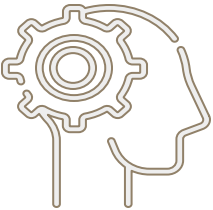


SuperDecisions 04

- You can rearrange the nodes
- You cannot connect nodes (boxes) without at least one component (node) (1)
- Create the following criteria and alternatives

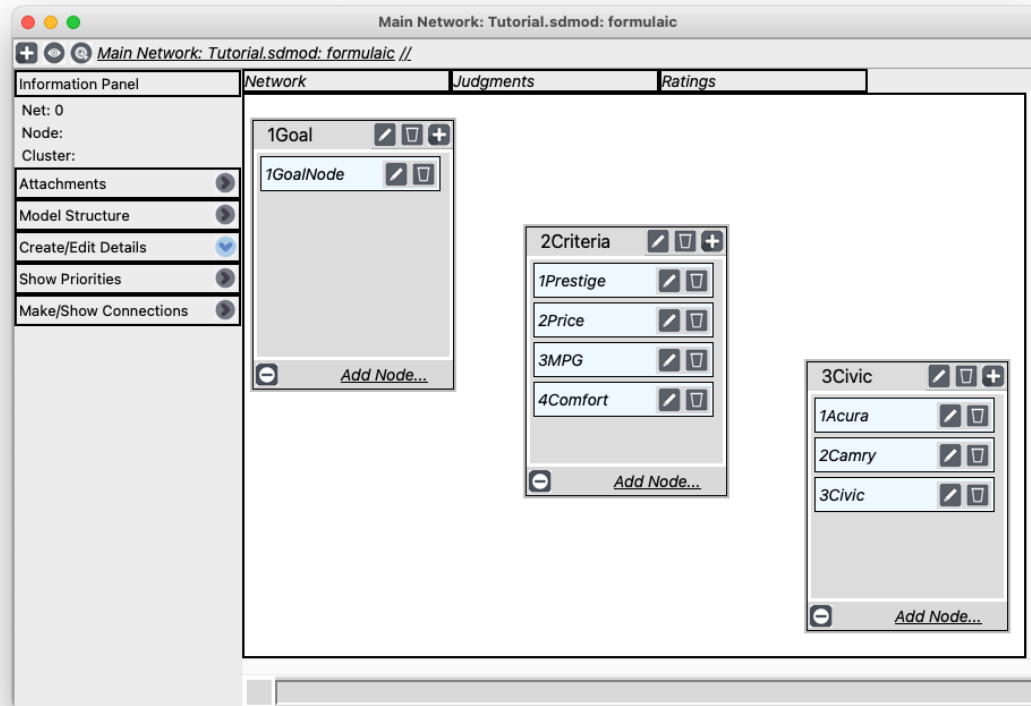


SUPERDECISIONS

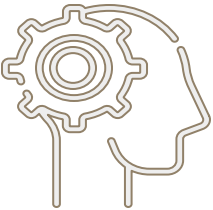


SuperDecisions 05

- You can rearrange the nodes
- You cannot connect nodes (boxes) without at least one component (node) (1)
- Create the following criteria and alternatives

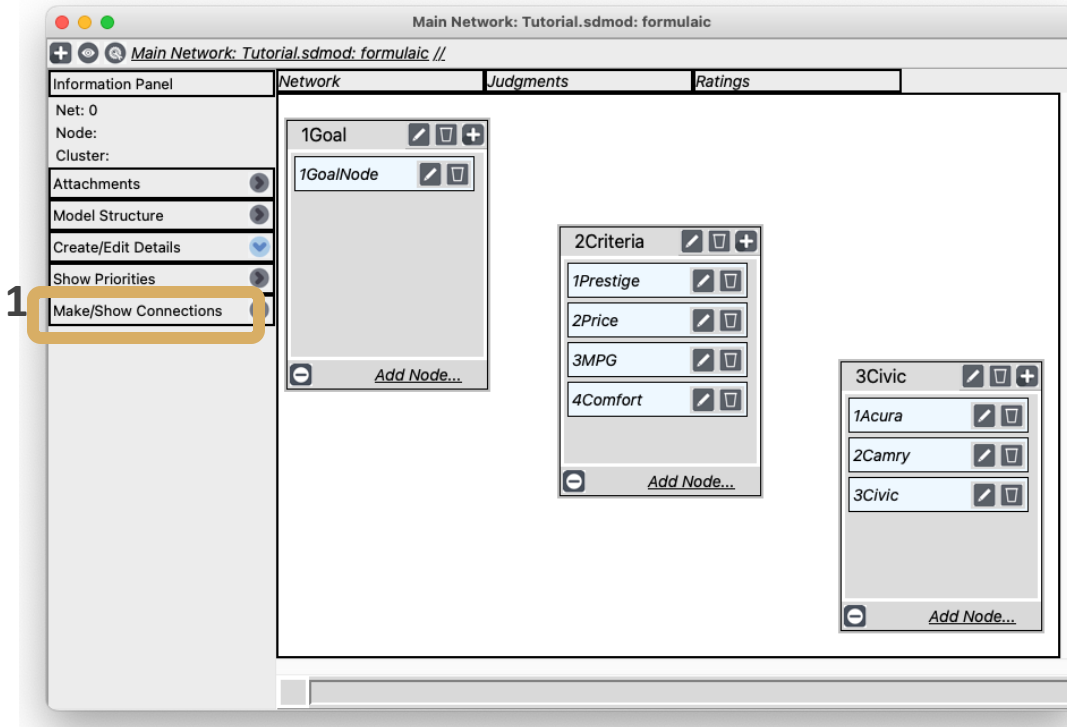


SUPERDECISIONS

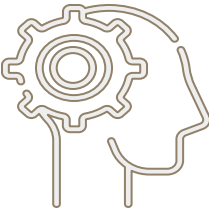


SuperDecisions 06

- At least in the Mac version, it is very buggy – save frequently!!
- For each node you can edit it (pen symbol), delete it (bin symbol), add a node (plus symbol) or minimize it (minus symbol)
- To connect levels, click the one you want and press “Make/Show Connections” (1)

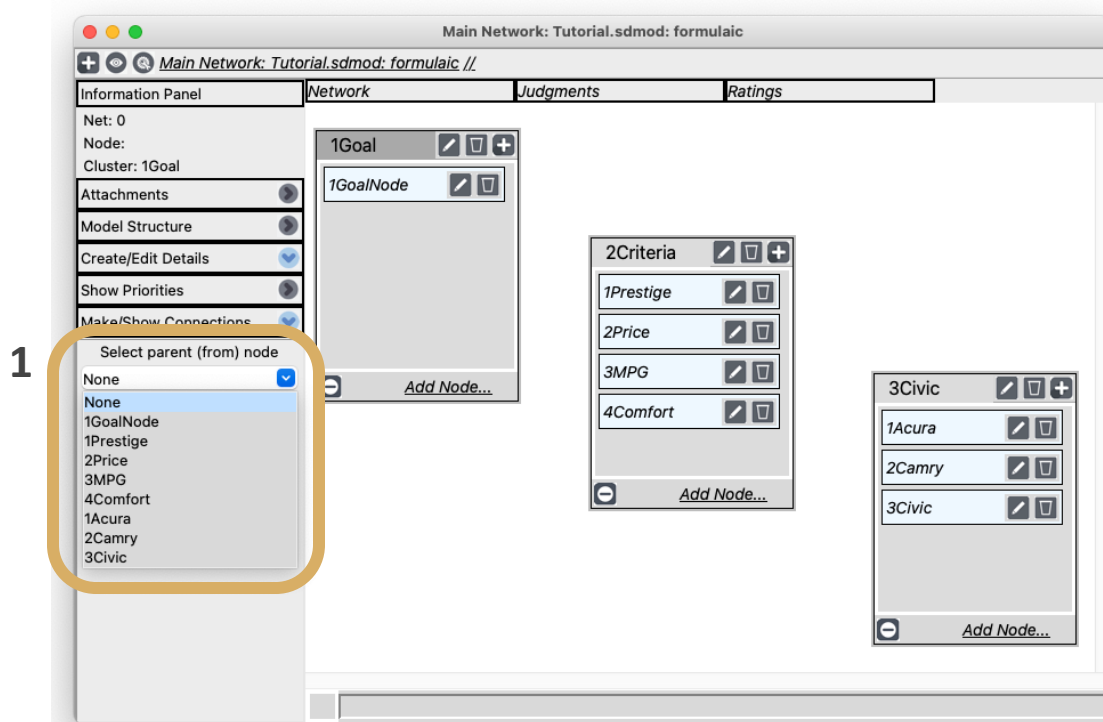


SUPERDECISIONS

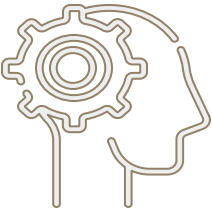


SuperDecisions 07

- Since AHP is a hierarchical model, you need to connect from parents (from) to children nodes (to)



SUPERDECISIONS



SuperDecisions 08

- Now connect to the child node
- Warning: You need to click the white space below the nodes after selecting the last node otherwise it won't be saved (2).

1

2

Main Network: Tutorial.sdmod: formulaic

Information Panel

Net: 0

Node: 1GoalNode

Cluster: 1Goal

Attachments

Model Structure

Create/Edit Details

Show Priorities

Make/Show Connections

1Goal

1GoalNode

2Criteria

1Prestige

2Price

3MPG

4Comfort

Add Node...

Select parent (from) node

1GoalNode

Select child (to) cluster

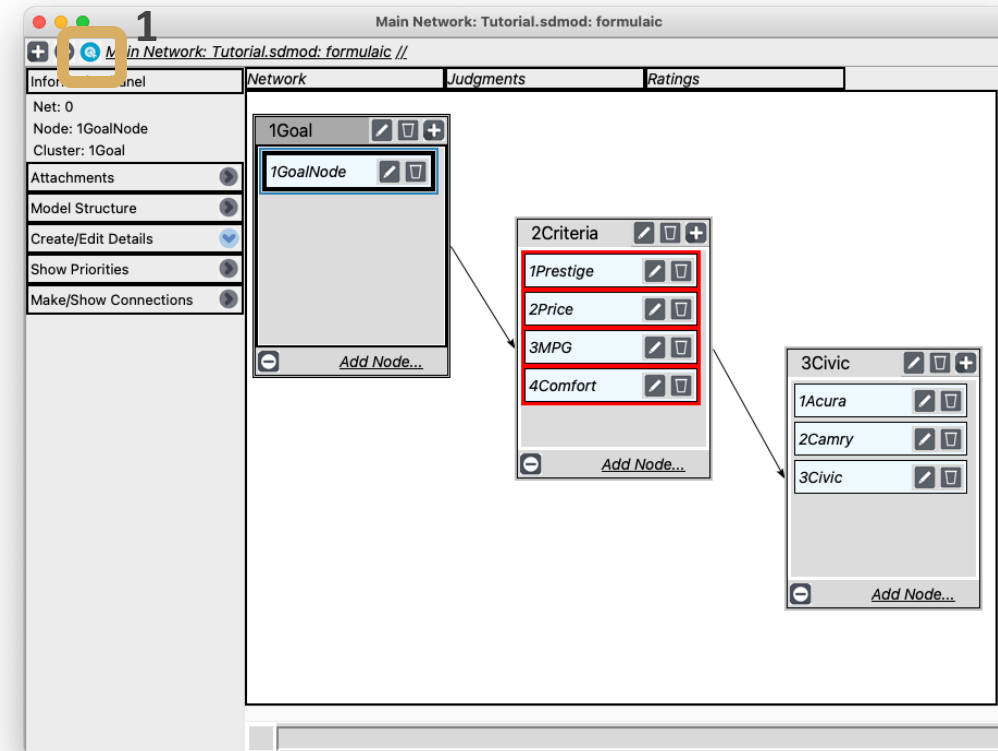
All

Nodes	Connected
1GoalNode	<input type="checkbox"/>
1Prestige	<input checked="" type="checkbox"/>
2Price	<input checked="" type="checkbox"/>
3MPG	<input checked="" type="checkbox"/>
4Comfort	<input checked="" type="checkbox"/>
1Acura	<input type="checkbox"/>
2Camry	<input type="checkbox"/>
3Civic	<input type="checkbox"/>

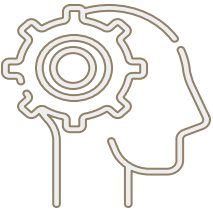
Add Node...

SuperDecisions 09

- Enable the “show connections” mode and check if all connections are correct.
- If you created a loop, right click the node and press “Remove self loop”



SUPERDECISIONS



SUPERDECISIONS

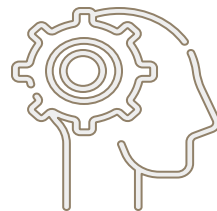
SuperDecisions 10

- Check if all options are correct in Computations → Unweighted Supermatrix → Graphical
- Now you understand why add numbers to nodes
- Notice that all weights are equally distributed (it will change when you input judgements)
- The same for the alternatives

Mac OS window title: Main Network: Tutorial.sdmod: formulaic: Unweighted Super Matrix

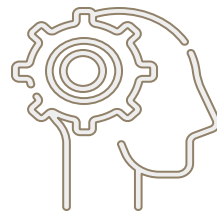
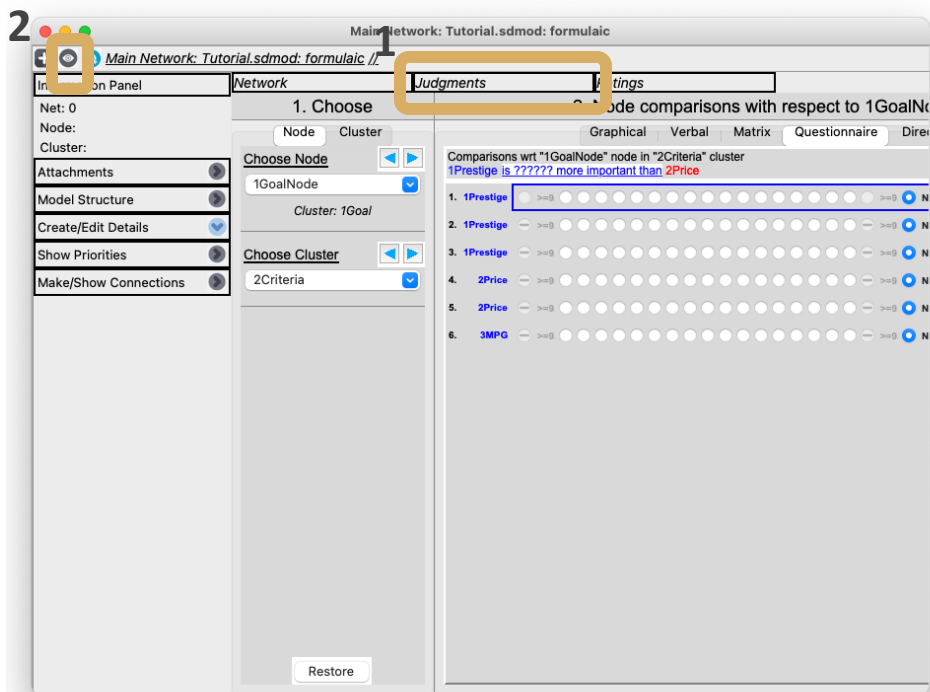
Clusters	Nodes	1GoalNode	1Prestige	2Price	3MPG	4Comfort	1Acura	2Camry	3Civic
1Goal	1GoalNode	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2Criteria	1Prestige	0.250000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	2Price	0.250000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	3MPG	0.250000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	4Comfort	0.250000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
3Civic	1Acura	0.000000	0.333333	0.333333	0.333333	0.333333	0.000000	0.000000	0.000000
	2Camry	0.000000	0.333333	0.333333	0.333333	0.333333	0.000000	0.000000	0.000000
	3Civic	0.000000	0.333333	0.333333	0.333333	0.333333	0.000000	0.000000	0.000000

Done



SuperDecisions 11

- To input judgement, use the “Judgements” panel (1)
- You can hide the information panel to gain more viewing space (2)



SuperDecisions 12

- We are going to input judgments by levels (nodes) (1)
- Let's explore the modes (2)

1

2

Main Network: Tutorial.sdmod: formulaic

Network Judgments Ratings

1. Choose

Node Cluster

Choose Node

1GoalNode

Cluster: 1Goal

Choose Cluster

2Criteria

Restore

2. Node comparisons with respect to resources

Graphical Verbal Matrix Questionnaire Direct

Comparisons wrt "1Goal"

1Prestige is ????? more important than 2Price

1. 1Prestige vs 2Price No coi

2. 1Prestige vs 3MPG No coi

3. 1Prestige vs 4Comfort No coi

4. 2Price vs 3MPG No coi

5. 2Price vs 4Comfort No coi

6. 3MPG vs 4Comfort No coi

3. Results

Nor... Hy...

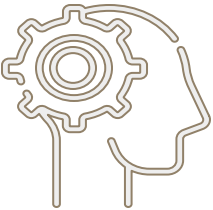
Inconsistency: 0.00000

1Prestige	0.25000
2Price	0.25000
3MPG	0.25000
4Comfort	0.25000

Completed Comparison

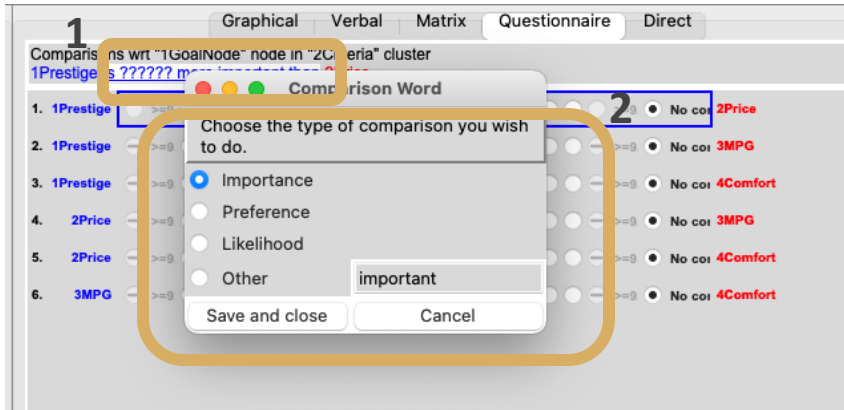
Copy to clipboard

SUPERDECISIONS



SuperDecisions 13

- By clicking on the “is ??? More important” you can change the phrasing
- The inconsistency level is updated each time you input new information (try to keep it under 0.1)

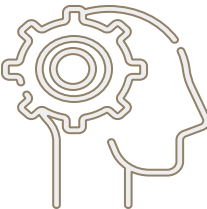


Nor... ▾

Hy... ▾

Inconsistency: 0.00000

1Prestige		0.05882
2Price		0.29412
3MPG		0.29412
4Comfort		0.35294



SUPERDECISIONS

SuperDecisions 14

- You check the inconsistencies on Matrix → Inconsistency → Inconsistency report
- Here the ranking is from the most inconsistent onwards
- Change the values according to the suggestions (or not!) and check it again.

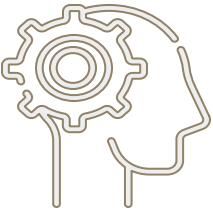
Graphical Verbal **Matrix** Questionnaire Direct

Comparisons wrt "1GoalNode" node in "2Criteria" cluster
 3MPG is ??????? times more likely than 4Comfort

Inconsistency ☒ Inconsistency Of Current Inconsistency Report

	2Price ~	3MPG ~	4Comfort ~
2Price ~	↑ 5	↑ 5	↑ 6
3MPG ~	← 0	← 0	← 0

Rank	Row	Col	Current Val	Best Val	Old Inconsist.	New Inconsist.	% Improvement
1.	1Prestige	4Comfort	6.000000	2.142857	9.449353e-11	5.687336e-12	NA
2.	2Price	3MPG	0.000000	1.000000	9.449353e-11	9.449353e-11	NA
3.	2Price	4Comfort	0.000000	1.200000	9.449353e-11	9.449353e-11	NA
4.	3MPG	4Comfort	0.000000	1.200000	9.449353e-11	9.449353e-11	NA
5.	1Prestige	2Price	5.000000	2.195122	9.449353e-11	9.729446e-11	NA
6.	1Prestige	3MPG	5.000000	2.195122	9.449353e-11	9.729446e-11	NA



SuperDecisions 15

- Check if you have entered all criteria and alternatives in Computations → Sanity Check

Main Network: Tutorial.sdmod: formulaic

Network Judgments Ratings

1. Choose

Node Cluster

Choose Node

1GoalNode

Cluster: 1Goal

Choose Cluster

2Criteria

2. Node comparisons with respect to 1GoalNode

Graphical Verbal Matrix Questionnaire Direct

Comparisons wrt "1GoalNode" node in "2Criteria" cluster
3MPG is ????? times more likely than 4Comfort

Inconsistency

2Price ~ 3MPG ~ 4Comfort ~

1Prestige ~

2Price ~

3MPG ~

↑ 5 ↑ 5 ↑ 6

← 0 ← 0

← 0

3. Results

Normal Hybrid

Inconsistency: 0.00000

1Prestige	0.05882
2Price	0.29412
3MPG	0.29412
4Comfort	0.35294

Network calculational warnings.

Incomplete node comparisons.	Full info	Fix info	Net
Incomplete node comparisons.	Full info	Fix info	Net
Incomplete node comparisons.	Full info	Fix info	Net
Incomplete node comparisons.	Full info	Fix info	Net
Incomplete node comparisons.	Full info	Fix info	Net
No alternatives	Full info	Fix info	Net

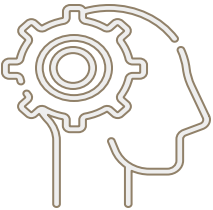
Restore

Copy to clipboard

Completed Comparison

Copy to clipboard

SUPERDECISIONS



SUPERDECISIONS

SuperDecisions 16

- Do the same for the subsequent levels

1. Choose

Node Cluster

Choose Node ◀ ▶

1Prestige ✓

Cluster: 2Criteria

Choose Cluster ◀ ▶

3Civic ✓

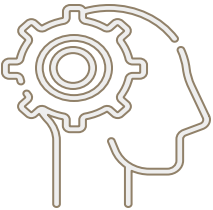
Comparisons

1Acura is ??

1. 1Acura

2. 1Acura

3. 2Camry



SuperDecisions 17

- Price is a nice example to input raw data instead of judgements (direct comparison)

Main Network: Tutorial.sdmod: formulaic

Main Network: Tutorial.sdmod: formulaic //

Network Judgments Ratings

1. Choose

Node Cluster

Choose Node ◀ ▶

2Price ▼

Cluster: 2Criteria

Choose Cluster ◀ ▶

3Civic ▼

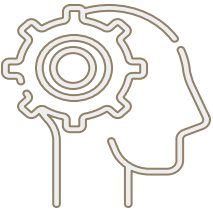
2. Node comparisons with respect to 2Price

Graphical Verbal Matrix Questionnaire **Direct**

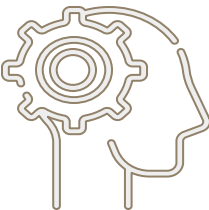
1Acura	35000
2Camry	28000
3Civic	20000

This is the direct data input area.
Type in new direct data here, and/or
Click the invert box invert priorities for this
direct data.

NOTE: Any changes made in direct data take
effect immediately and overwrite
pre-existing data inputted in the
other modes.



SUPERDECISIONS



SuperDecisions 18

- As in price lower is better (1), we can invert the scale so it aligns with our judgement (2)
- After inputting all the judgements, remember to save the model.

1

2

Main Network: Tutorial.sdmod: formulaic //

Network Judgments Ratings

1. Choose

Node Cluster

Choose Node

2Price

Cluster: 2Criteria

Choose Cluster

3Civic

Restore

2. Node comparisons with respect to 2Price

Graphical Verbal Matrix Questionnaire Direct

1Acura 35000

2Camry 28000

3Civic 20000

This is the direct data input area. Type in new direct data here, and/or Click the invert box invert priorities for this direct data.

NOTE: Any changes made in direct data take effect immediately and overwrite pre-existing data inputted in the other modes.

☐ Invert

3. Results

Normal Hybrid

Inconsistency: 0.00000

1Acura	0.42169
2Camry	0.33735
3Civic	0.24096

Completed Comparison

Copy to clipboard

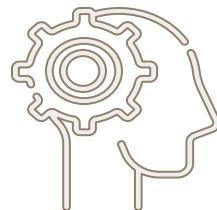
SuperDecisions 19

- As for the results let's start with the Unweighted Super Matrix

Main Network: Tutorial.sdmod: formulaic: Unweighted Super Matrix

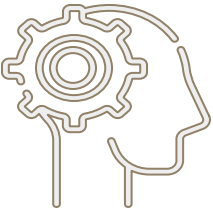
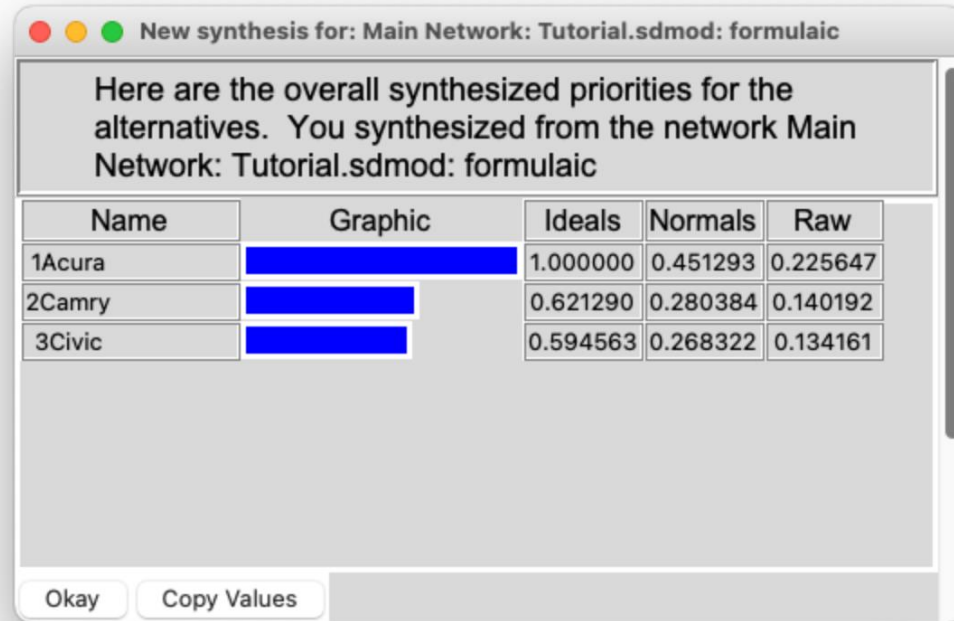
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1Goal	1GoalNode	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2Criteria	1Prestige	0.055527	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	2Price	0.308581	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	3MPG	0.255844	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	4Comfort	0.380049	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
3Civic	1Acura	0.000000	0.658630	0.250000	0.281690	0.333333	0.000000	0.000000	0.000000
	2Camry	0.000000	0.262753	0.312500	0.309859	0.333333	0.000000	0.000000	0.000000
	3Civic	0.000000	0.078617	0.437500	0.408451	0.333333	0.000000	0.000000	0.000000

Done



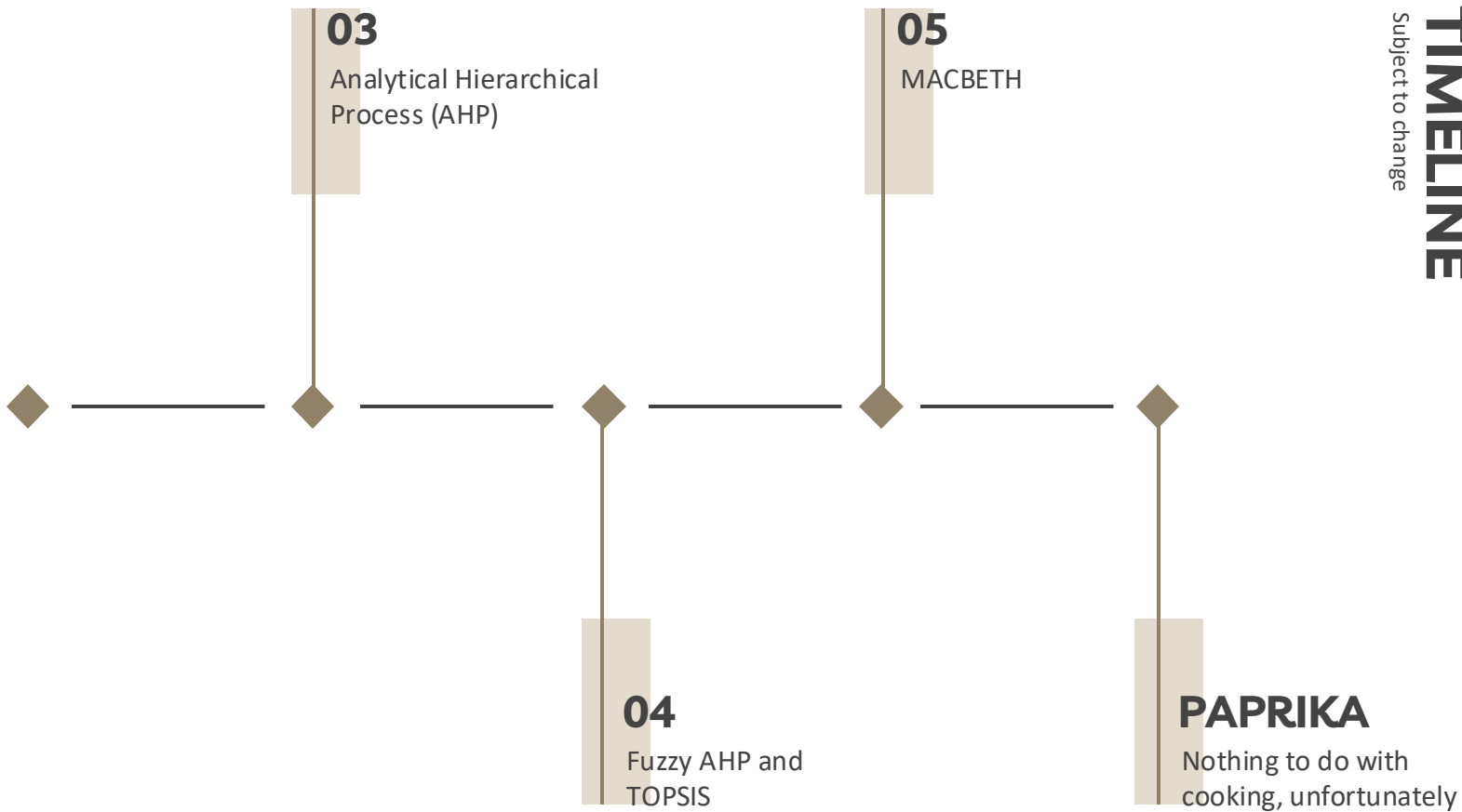
SuperDecisions 20

- To get the ranked alternatives and weights use Computations → Synthesize
- Remember to name the alternatives 3Alternatives to ensure this option works well



TIMELINE

Subject to change





REFERENCES

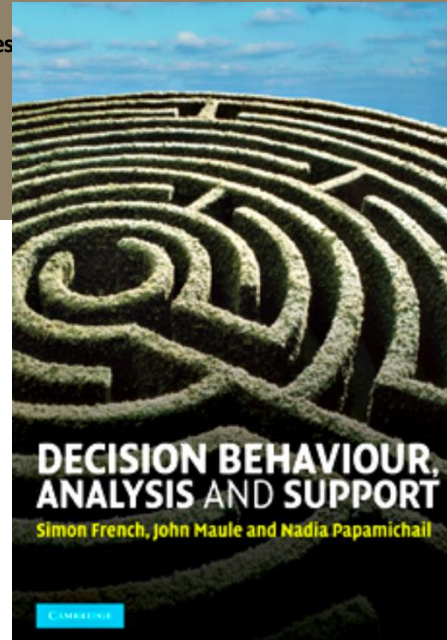
Today's content was mainly based on

- 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

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- 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.
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- Forman, E. H., & Selly, M. A. (2001). Decision by objectives. World Scientific.



REFERENCES

THANKS

Does anyone have any questions?
Contact me at:

fellipe.martins@mackenzie.br
+11 95619 0585 (business hours)
fellipemartins.com.br

