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Solvay Brussels School
Economics & Management



P R O M E T H E E
M E T H O D S

MultiCriteria Decision Aid with **PROMETHEE & GAIA**

*How to make **better** and more **sustainable decisions***

Πανεπιστήμιο Μακεδονίας
Θεσσαλονίκη, Ιουλίου 4-6, 2017

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Course Schedule



- **Tuesday 4 – What? Why? How?**
 - What is multicriteria decision aid.
 - Why you should use multicriteria decision aid.
 - **PROMETHEE & GAIA**
- **Wednesday 5 – The software**
 - Advanced features.
 - Using **PROMETHEE** and the **Visual PROMETHEE** software.
 - Hands-on training.
- **Thursday 6 – Practice**
 - Exercises.
 - Case studies (homeworks).

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Tuesday 4

What? Why? How?



- What is multicriteria decision aid:
 - Optimization vs multicriteria decision aid.
 - Sustainable decisions.
 - Models and main approaches.
- Why you should use multicriteria decision aid.
- **PROMETHEE & GAIA.**

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Decisions



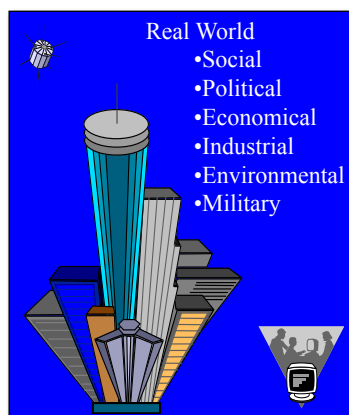
- **Personal decisions**
 - Choose a restaurant tonight
 - Choose a university
 - Purchase a new phone, a new car, ...
- **Business decisions**
 - Develop a new product
 - Choose a computer system
 - Investments, strategies, project management, ...
- **Political decisions**
 - Join the EU... Leave the EU...
 - Build a new hospital
 - Regional investment, taxes, ...



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Decision Making



- Describe,
- Understand,
- Manage.

2 Approaches :

- Qualitative approach,
- **Quantitative approach.**

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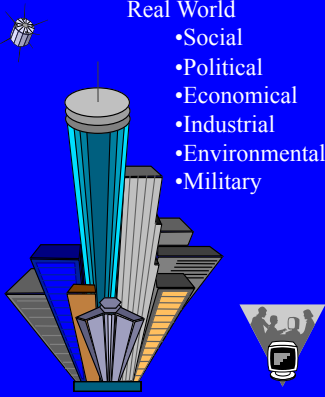
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PROMETHEE

RESEARCH

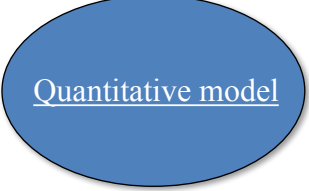
Decision Aid



Real World

- Social
- Political
- Economical
- Industrial
- Environmental
- Military





Quantitative model

- Possible decisions?
- How to compare them?
- Preferences, Objectives?

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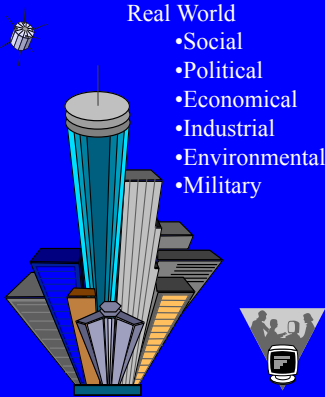
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PROMETHEE

RESEARCH

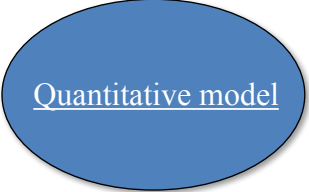
Decision Aid



Real World

- Social
- Political
- Economical
- Industrial
- Environmental
- Military





Quantitative model

- Approximation to real world!
- Decision Aid.

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Quantitative Model?

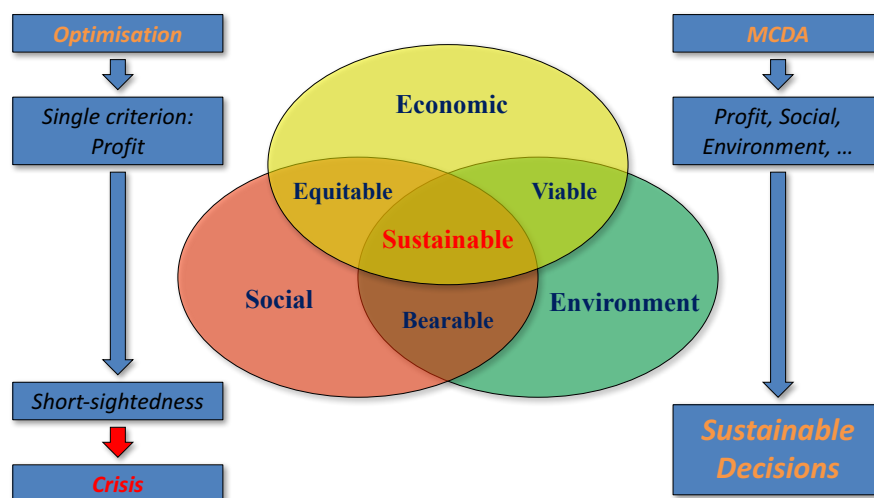


- Describe possible decisions (actions)?
 - List, variables, ...
- Objective? Best decision? Best choice?
 - Minimize costs?
 - Maximize profit?
 - Maximize quality?
 - Minimize impacts?
- Optimization models?
- Or **MCDA** (**M**ulti**C**riteria **D**ecision **A**id) models...

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MCDA vs Optimisation



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Some Decision or Evaluation Problems



- Locating a new plant, a new shop, ...
- Human resources management.
- Purchasing equipment.
- Assessing the quality of suppliers.
- Evaluating projects.
- Selecting an investment strategy.
- Making political decisions...

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What? Why? How?



- What are we facing?
 - Decision problems involving multiple and conflicting issues.
 - Decision problems involving the future of Mankind.
- Why should we care?
 - Robin Hood is dead.
 - Short-term profit is ruling.
- How can we face it?
 - Think ethical.
 - Share. React. Act.
 - Need for models to avoid subjectivity and unethical behavior.



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Which models?



- Qualitative models?
 - Subjective!
- Unicriterion models?
 - Less subjective,
 - Short-sighted!
- Multicriteria models?
 - More open,
 - Still models...

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Unicriterion vs Multicriteria Model



- **Unicriterion model:**

$$\text{Optimise } \{g(a) | a \in A\}$$

 - Mathematically **well-stated**:
 - Optimal solution,
 - Complete ranking of the actions.
 - Socio-economically **ill-stated**:
 - Single criterion? Not realistic.
 - Notion of criterion: perception thresholds, ...

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Unicriterion vs Multicriteria Model



- **Multicriteria model:**

$$\text{Optimise } \{g_1(a), g_2(a), \dots, g_k(a) | a \in A\}$$

- Mathematically **ill-stated**:
 - No optimal solution,
 - No mathematical meaning.
- Socio-economically **well-stated**:
 - Closer to real world decision problem,
 - Search for a compromise solution.

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Multicriteria Table



- **Actions:**
 - Possible decisions,
 - items to evaluate.
- **Criteria:**
 - quantitative,
 - qualitative.

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PROMETHEE

Multicriteria Table

	Crit. 1 (/20)	Crit. 2 (rating)	Crit. 3 (qual.)	Crit. 4 (Y/N)	...
Action 1	18	135	G	Yes	...
Action 2	9	147	B	Yes	...
Action 3	15	129	VG	No	...
Action 4	12	146	VB	?	...
Action 5	7	121	G	Yes	...
...	...	...	...	...	...

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PROMETHEE

Plant Location

	Investment (M€)	Costs (k€)	Environm. (impact)	...
Site 1	18	135	G	...
Site 2	9	147	B	...
Site 3	15	129	VG	...
Site 4	12	146	VB	...
Site 5	7	121	G	...
...	...	...	...	...

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Purchase Options



	Price (€)	Reliability (days)	Maintenance (estimate)	...
Product A	18	135	G	...
Product B	9	147	B	...
Product C	15	129	VG	...
Product D	12	146	VB	...
Product E	7	121	G	...
...	...	...	...	...

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A Simple Example



*The purchase of a new car
by a Greek family*

Objectives:

- Economy (price),
- Usage (fuel consumption),
- Performance (power),
- Space,
- Comfort.

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Multicriteria Table

Cars	Price	Power	Fuel	Space	Comfort
Tourism A	26.000 €	75	8,0	average	average
Sport	29.000 €	110	9,0	very bad	bad
Tourism B	25.500 €	85	7,0	good	average
Luxury 1	38.000 €	90	8,5	good	very good
Economic	15.000 €	50	7,5	bad	very bad
Luxury 2	35.000 €	85	9,0	very good	good

- Best buy?
- Best compromise?
- Priorities of the buyer?



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Who is the decision maker?

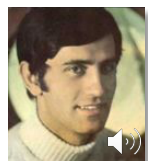


Dad (Ιάσων)?

He would prefer to save money for holidays in sunny Belgium but needs space for mom's suitcases...

Mom (Ελευθερία)?

She would prefer a red one...



The kid (Γιώργος)?

He doesn't care too much about money... More about speed and ρεμπέτικο τραγούδι!

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One or Several Stakeholders ?



- Single stakeholder:
 - One actor (the decision maker).
 - One multicriteria table and one preference structure.
- Multiple stakeholders:
 - Several actors (including decision maker(s)).
 - Several multicriteria tables and preference structures.
 - Search for consensus.

Example



- A Greek family.
- Three stakeholders (“decision makers”):
 - *Ιάσων* (dad),
 - *Ελευθερία* (mom),
 - *Γιώργος* (the kid).
- Three scenarios.
- Three multicriteria tables:
 - Different priorities.
 - Subjective evaluation of comfort.

Homework Assignment



- For Thursday.
- By small groups of 4 to 6 students.
- Set up a multicriteria decision problem:
 - Actual or fictive.
 - Including minimum 6 actions, 5 criteria and 2 scenarios.
 - Prepare the multicriteria evaluation table.
 - Think about preference functions and criteria weights.

How to?



- What is the problem?
- What are the issues?
- Who is involved (stakeholders)?
- What is possible (decisions)?
- What is at stake (objectives)?
- How to measure achievement (criteria)?

➤ Modeling...

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Modeling... 1... 2... 3...

2. Define the criteria

1. Define the actions

	g_1	g_2	g_3	...
a	$g_1(a)$	$g_2(a)$	$g_3(a)$	...
b	$g_1(b)$	$g_2(b)$	$g_3(b)$	...
c	...			
...	...			

3. Model preferences

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1. Defining the actions

- Challenge:
 - Be exhaustive.
 - Open the options.
- Definition: Let A the set of actions. A can be defined:
 - **in extension:**
 - by enumeration of its elements.
 - relatively small number of actions.
 - **in comprehension:**
 - by constraints on a set of decision variables.
 - (Cf. linear programming)
 - large number or infinity of actions.

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Some properties of the set of actions



The set of actions $\mathcal{A}$ can be:

- **stable**: a priori defined, doesn't evolve.
or
- **evolutive**: can evolve during the procedure.
- **globalized**: mutually exclusive elements.
or
- **fragmented**: combinations of actions are considered.

2. Defining the criteria



- **Definition**:
function g defined on $\mathcal{A}$, taking its values in a totally ordered set, and representing an objective of the decision-maker(s).
- **Challenge**:
 Consistent family of criteria:
 - Include all aspects of the decision problem, all the objectives of the decision-maker(s),
 - Avoid redundancies.



Qualitative vs Quantitative Criteria



- Quantitative criteria:
 - Natural numerical scale.
- Qualitative criteria:
 - Qualitative ordinal scale (ex: Likert scales).
 - Maximum 9 levels (7 ± 2) to ensure a consistent evaluation.
 - Presence of a neutral level?
 - Examples:
 - Very good, Good, Average, Bad, Very bad
 - Yes, No
 - ++, +, 0, -, --
 - ++, +, -, --
 - Underlying numerical scale (coding).

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3. Modeling preferences



- Problem:

How to compare two actions
 a and b to each other?
- A first model: 3 possible results:
 1. Preference: aPb or bPa
 2. Indifference: aIb
 3. Incomparability: aRb

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Traditional preference structure (unicriterion)



- Optimisation of a function g on A

$$\forall a, b \in A: \begin{cases} aPb & \Leftrightarrow g(a) > g(b) \\ aIb & \Leftrightarrow g(a) = g(b) \end{cases}$$
- Consequences:

R is empty
P is transitive
I is transitive
- Complete ranking.

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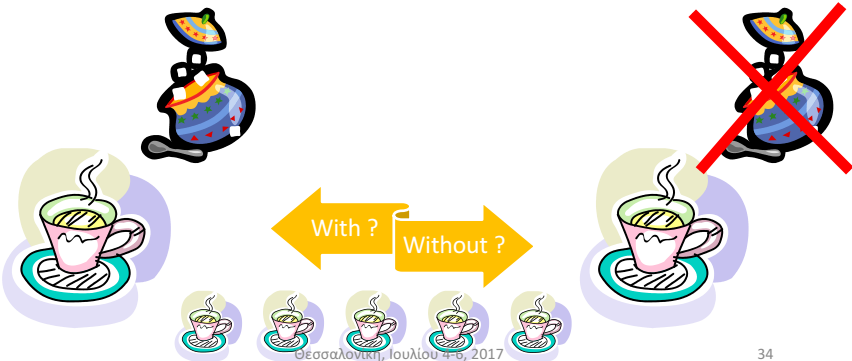
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The notion of indifference threshold



- Problem: Indifference can be intransitive.
Cf. Coffee cup paradox (Luce, 1956)



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The notion of indifference threshold



- Problem: Indifference can be intransitive.
Cf. Coffee cup paradox (Luce, 1956)

- Introduction of an indifference threshold:

$$\forall a, b \in A: \begin{cases} aPb & \Leftrightarrow g(a) > g(b) + q \\ aIb & \Leftrightarrow |g(a) - g(b)| \leq q \end{cases}$$

- Quasi-order : P is transitive, but not I .

Other preference structures



- Variable indifference threshold
⇒ Interval order.
- Preference + indifference thresholds
⇒ Pseudo-order.
- Models including incomparability
⇒ Partial orders.
- Valued preference structures.



Different Problematics

	g_1	g_2	g_3	...
a	$g_1(a)$	$g_2(a)$	$g_3(a)$	...
b	$g_1(b)$	$g_2(b)$	$g_3(b)$	...
c	...			
...	...			

Evaluations

- n actions
- k criteria

- α - **choice**: determine a subset of actions (the « best ones »).
- β - **sorting**: sort actions in predefined categories.
- γ - **ranking**: rank from the best to the worst action.
- δ - **description**: describe actions and their consequences.

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Unicriterion Model: Optimization

- Optimal solution
 - Maximum or minimum of criterion value.
 - Mathematically well-defined.
 - Generally exists.
- Optimization algorithms
 - Adapted to specific cases (linear programming, branch and bound, network optimization, ...).
 - "Proved".

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Multicriteria Model: Dominance and efficiency



- « Objective ».
- Based on a unanimity principle:

$$a \text{ dominates } b \Leftrightarrow g_h(a) \geq g_h(b) \quad \forall h$$

- Efficiency: a is efficient if it is not dominated by any other action.
- Problems:
 - Dominance is poor (few dominances),
 - Many actions are efficient.

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Multicriteria Table



Cars	Price	Power	Fuel	Space	Comfort
Tourism A	26.000 €	75	8,0	average	average
Sport	29.000 €	110	9,0	very bad	bad
Tourism B	25.500 €	85	7,0	good	average
Luxury 1	38.000 €	90	8,5	good	very good
Economic	15.000 €	50	7,5	bad	very bad
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- Best buy?
- Best compromise?
- Priorities of the buyer?



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Objections to Dominance



I	g_1	g_2
a	100	100
b	20	30

II	g_1	g_2
a	100	30
b	20	100

III	g_1	g_2
a	100	99
b	20	100

- a efficient
- a preferred to b

- a and b efficient
- a and b incomp.

- a and b efficient
- a preferred to b

IV	g_1	g_2
a	100	99
b	99	100

V	g_1	g_2
a	100	100
b	99	99

- a and b efficient
- a and b indifferent

- a efficient
- a and b indifferent

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Some Characteristics for a good multicriteria method



- Take into account **deviations** between evaluations.
- Take **scale** effects into account.
- Build either a **partial** (P, I, R) or a **complete** (P, I) ranking of the actions.
- Stay sufficiently **simple**:
 - **no** black box,
 - **no** technical parameters.

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A common approach:
The weighted sum

Criteria

	g_1	g_2	g_3	...
a	$g_1(a)$	$g_2(a)$	$g_3(a)$	...
b	$g_1(b)$	$g_2(b)$	$g_3(b)$	...
c	...			
...	...			
	w_1	w_2	w_3	...

Actions or Decisions

Weights of the criteria

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A common approach:
The weighted sum

- Global value for a :

$$V(a) = w_1 g_1(a) + w_2 g_2(a) + \dots$$
- a is preferred to b if:

$$V(a) > V(b)$$

(if all criteria are to maximise)

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Weighted Sum

Example 1



	g_1	g_2	g_3	g_4	g_5
a	100	100	100	100	55
b	85	85	85	85	100
	1/5	1/5	1/5	1/5	1/5

- $V(a) = 91$ $V(b) = 88$
- Total and uncontrolled compensation of weaknesses by strengthes.

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Weighted Sum

Example 2



	g_1	g_2
a	100	0
b	0	100
c	50	50
d	50	50
	1/2	1/2

- $V(a) = V(b) = V(c) = V(d) = 50$
- Elimination of conflicts – Loss of information.

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Weighted Sum

Example 3



*“Profit is approximately 2 times more important than time savings;
0.7 for profit and 0.3 for time savings.”*

	g_1 (BF)	g_2 (min)
a	60	60
b	48	70
	0.7	0.3

$$V(a) = 60$$

$$V(b) = 54.6$$

a is ranked 1st.

Weighted Sum

Example 3



*“Profit is approximately 2 times more important than time savings;
0.7 for profit and 0.3 for time savings.”*

	g_1 (FF)	g_2 (min)
a	10	60
b	8	70
	0.7	0.3

$$V(a) = 25$$

$$V(b) = 26.6$$

b is ranked 1st!



Weighted Sum

Example 3



	g_1 (BF)	g_2 (min)
a	60	60
b	48	70
	0.7	0.3

$V(a) = 60$
 $V(b) = 54.6$

a is ranked 1st.

	g_1 (FF)	g_2 (min)
a	10	60
b	8	70
	0.7	0.3

$V(a) = 25$
 $V(b) = 26.6$

b is ranked 1st.

→ Significance of the “weights” ! ←

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Multicriteria Decision Aid



- Multiattribute utility theory (MAUT).
- Outranking methods.
- Interactive methods.
- Multiobjective programming.
- ...

Since 1970, numerous developments:
conferences, papers, books,
applications, software...

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Multiattribute Utility Theory



- Single synthesis criterion (aggregation).

$$U(a) = U(g_1(a), g_2(a), \dots, g_k(a))$$

- Existence?
- Construction?
- Mathematical form?

➔ additive?

$$U(a) = \sum_{j=1}^k U_j(g_j(a))$$

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Multiattribute Utility Theory



- Construction method:
 - direct,
 - indirect.
- Information-intensive for the decision maker. (quantity of information vs reliability?).
- Not flexible (sensitivity analyses).
- Far away from the original decision problem structure:

multicriteria → unicriterion

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Outranking Methods



- Majority principle (vs unanimity for dominance).
- Pairwise comparison of actions.
- Closer to the decision problem.
- **ELECTRE** methods (1968-).
- **PROMETHEE & GAIA** methods (1982-).

Tuesday 4

What? Why? How?



- What is multicriteria decision aid.
- Why you should use multicriteria decision aid:
 - Facing complexity and conflicting issues.
 - Single decision maker context.
 - Collaborative group decision.
 - Negotiations between parties or stakeholders.
- **PROMETHEE & GAIA.**

Tuesday 4

What? Why? How?

- What is multicriteria decision aid.
- Why you should use multicriteria decision aid.
- **PROMETHEE & GAIA:**
 - Data and preference modeling.
 - **PROMETHEE** rankings.
 - **GAIA** visual analysis.
 - Sensitivity analyses.
 - Group decision and negotiation.

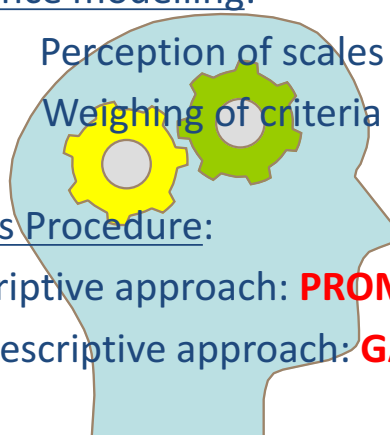
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Decision Aid Methods

- Preference modelling:
 - Perception of scales
 - Weighing of criteria
- Analysis Procedure:
 - Prescriptive approach: **PROMETHEE**
 - Descriptive approach: **GAIA**



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Why **PROMETHEE**?



- Proven methodology:
 - 30 years development,
 - Over 1570 published scientific papers.
- « Simplicity ».
- Visual tools.
- Sensitivity analysis tools.
- Interactivity.
- **Visual PROMETHEE** software.

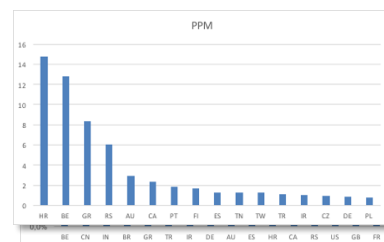
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Some statistics...

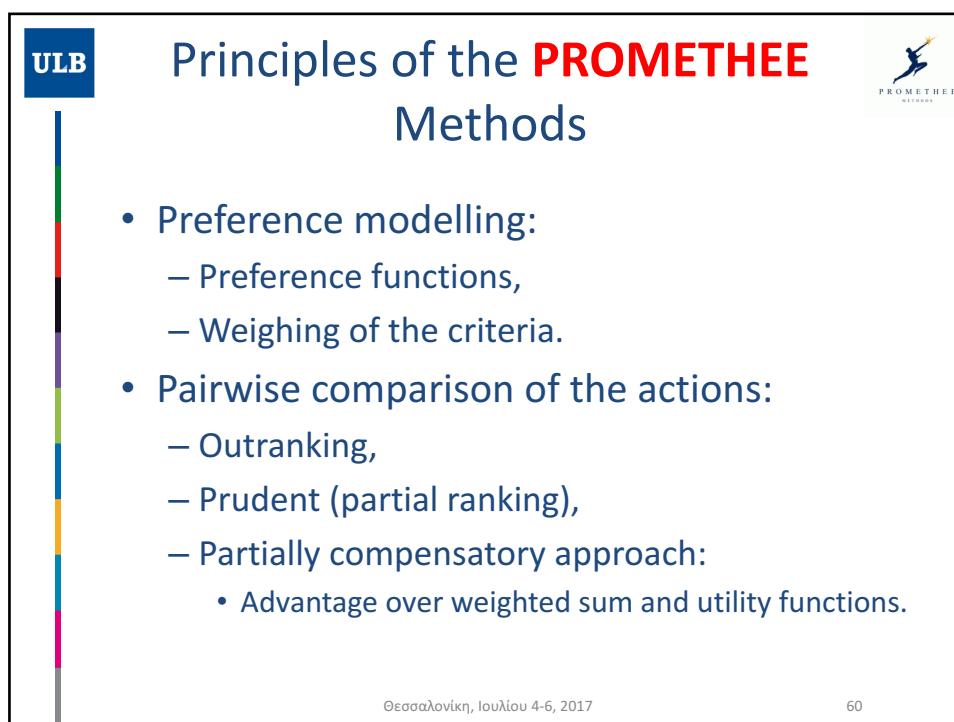
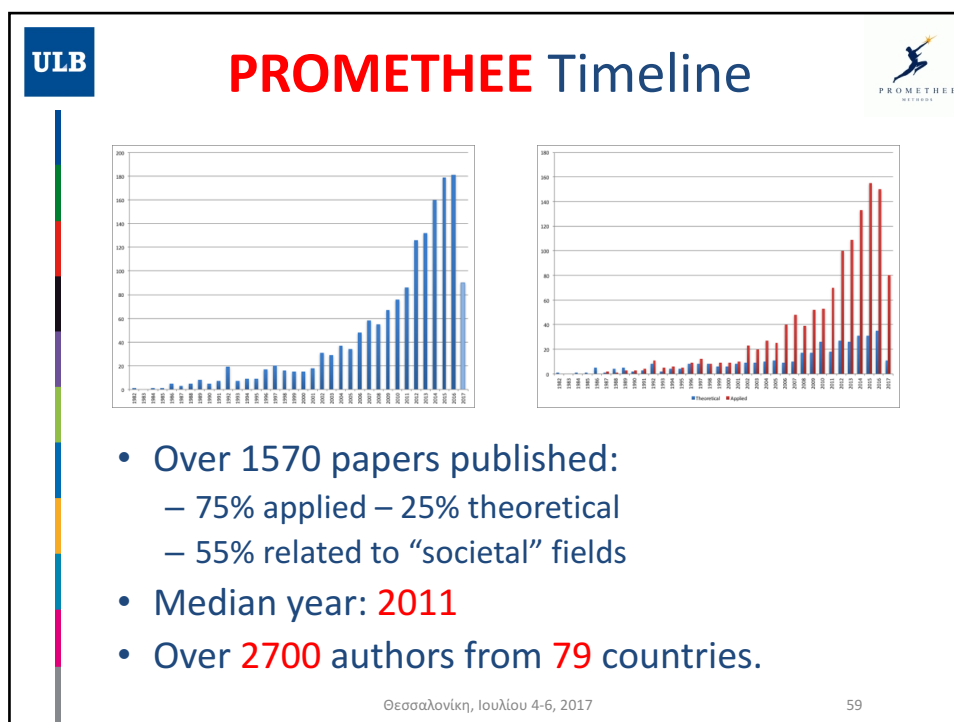


- First paper published in **1982** by J-P. Brans.
- Over **1570** published papers as of today.
- **92** papers published by **153** Greek authors, from **1989** to 2017
(worldwide #**5**, after Belgium, China, India and Brazil; #**3** PPM)
- Main fields of application:
 - Environment
 - Industry
 - Services / Public sector
 - Energy
 - Finance



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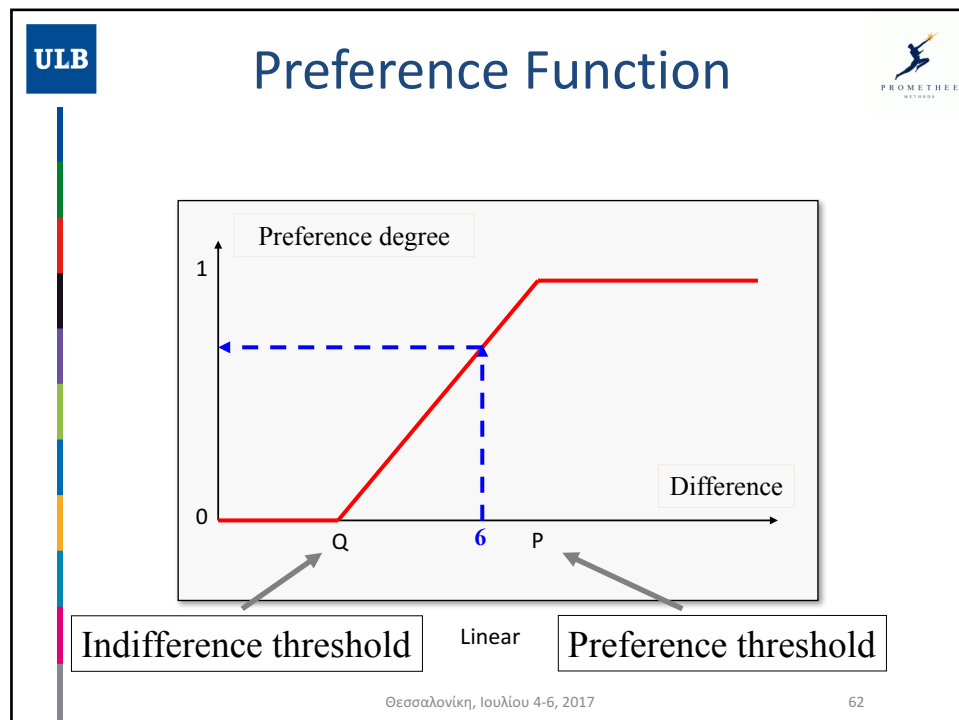
Comparison of 2 Actions

PROMETHEE

	Crit. 1 (/20)	Crit. 2 (rating)	Crit. 3 (qual.)	Crit. 4 (Y/N)	...
Action 1	18	135	G	Yes	...
Action 2	9	147	Difference = 6		
Action 3	15	129	VG	No	...
Action 4	12	146	VB	?	...
Action 5	7	121	G	Yes	...
...	...	...	...	...	...

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PROMETHEE

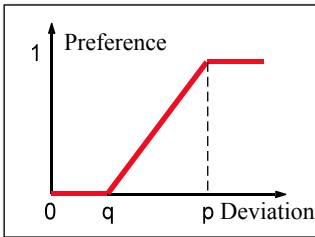


Pref (Eco.,Lux.)

		Economic		Luxury 1		
1,0	-23000	15000	Price	38000		0,0
0,0		50	Power	90	+40	1,0
0,5	-1,0	7,5	Fuel	8,5		0,0
0,0		B	Space	G	+2	0,5
0,0		VB	Comfort	VG	+4	1,0

Pref (Lux.,Eco.)

						Wght
0,0						1/5
1,0						1/5
0,0						1/5
0,5						1/5
1,0						1/5



☐ $\text{Pref (Eco.,Lux.)} = 0,3$
 $= (1 + 0 + 0,5 + 0 + 0) / 5$

☐ $\text{Pref (Lux.,Eco.)} = 0,5$
 $= (0 + 1 + 0 + 0,5 + 1) / 5$

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PROMETHEE

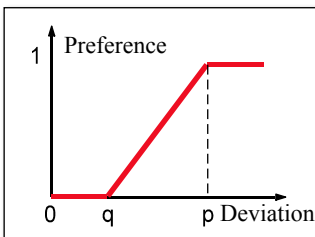


Pref (Eco.,Lux.)

		Economic		Luxury 1		
1,0	-23000	15000	Price	38000		0,0
0,0		50	Power	90	+40	1,0
0,5	-1,0	7,5	Fuel	8,5		0,0
0,0		B	Space	G	+2	0,5
0,0		VB	Comfort	VG	+4	1,0

Pref (Lux.,Eco.)

						Wght
0,0						2/7
1,0						1/7
0,0						2/7
0,5						1/7
1,0						1/7



☐ $\text{Pref (Eco.,Lux.)} = 0,43$
 $= (2 \times 1 + 0 + 2 \times 0,5 + 0 + 0) / 7$

☐ $\text{Pref (Lux.,Eco.)} = 0,36$
 $= (0 + 1 + 0 + 0,5 + 1) / 7$

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Pairwise Comparisons



- For each criterion g_j :
 - Preference function P_j
 - Weight w_j
- Multicriteria preference degree of a over b :

$$\pi(a,b) = \sum_{j=1}^k w_j P_j(a,b)$$

– Properties:

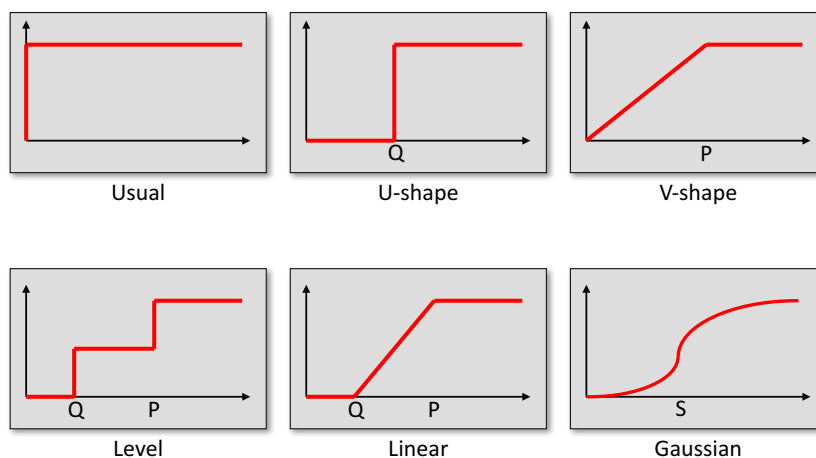
$$0 \leq \pi(a,b) \leq 1$$

$$\pi(a,b) > 0 \Rightarrow \pi(b,a) = 0$$

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Preference Functions (as in **Visual PROMETHEE** software)



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ULB

PROMETHEE

Pref (Eco.,Lux.)

Pref (Lux.,Eco.)

		Economic		Luxury 1	
1,0	-23000	15000	Price	38000	0,0
0,0		50	Power	90	+40
0,5	-1,0	7,5	Fuel	8,5	
0,0		B	Space	G	+2
0,0		VB	Comfort	VG	+4
					1,0

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Computation of Preference Flows

$\pi(a,b)$	<i>Tour.A</i>	<i>Sport</i>	<i>Tour.B</i>	<i>Lux.1</i>	<i>Econ.</i>	<i>Lux.2</i>	$\phi^+(a)$
<i>Tour.A</i>	0,00	0,34	0,00	0,21	0,26	0,22	0,21
<i>Sport</i>	0,20	0,00	0,16	0,24	0,30	0,24	0,23
<i>Tour.B</i>	0,15	0,55	0,00	0,32	0,45	0,33	0,36
<i>Lux.1</i>	0,18	0,45	0,10	0,00	0,50	0,15	0,28
<i>Econ.</i>	0,20	0,34	0,14	0,30	0,00	0,35	0,27
<i>Lux.2</i>	0,24	0,30	0,10	0,04	0,60	0,00	0,26
$\phi^-(a)$	0,19	0,40	0,10	0,22	0,42	0,26	
$\phi(a)$	0,02	-0,17	0,26	0,06	-0,15	0,00	

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Preference Flows



- Relative scores computed for the actions.
- Leaving (+) and entering (−) flows:
 - Strength: $0 \leq \phi^+ \leq 1$
 - Weakness: $0 \leq \phi^- \leq 1$
- Net flow:
 - Balance: $-1 \leq \phi = \phi^+ - \phi^- \leq +1$
- Unicriterion net flows:
 - Standardized scores for each criterion:
 $\text{criterion } f_j \Rightarrow -1 \leq \phi_j \leq +1$

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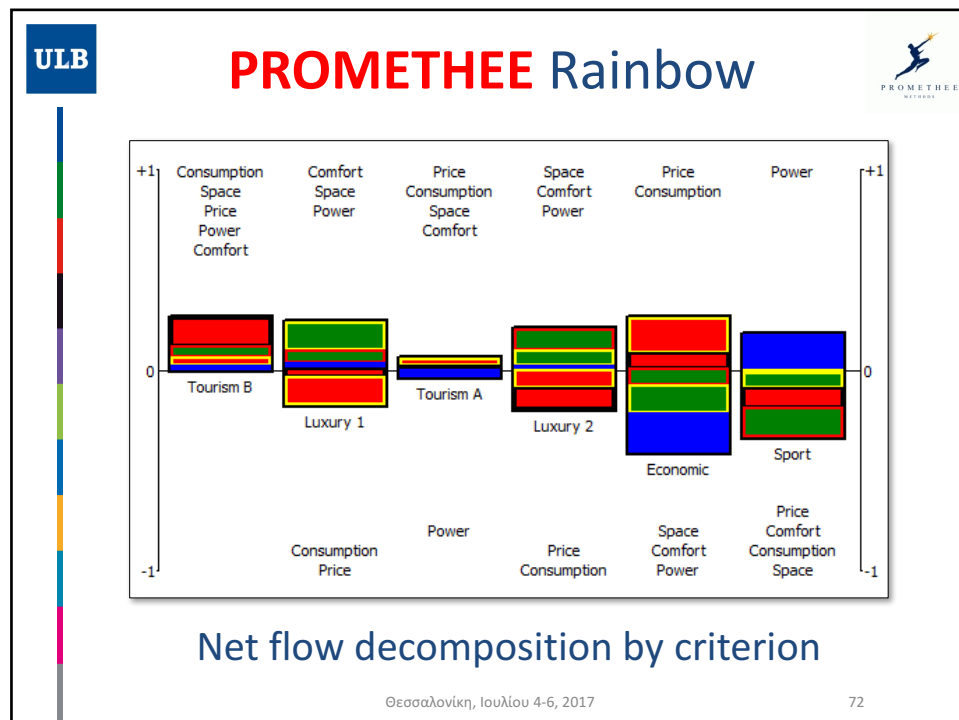
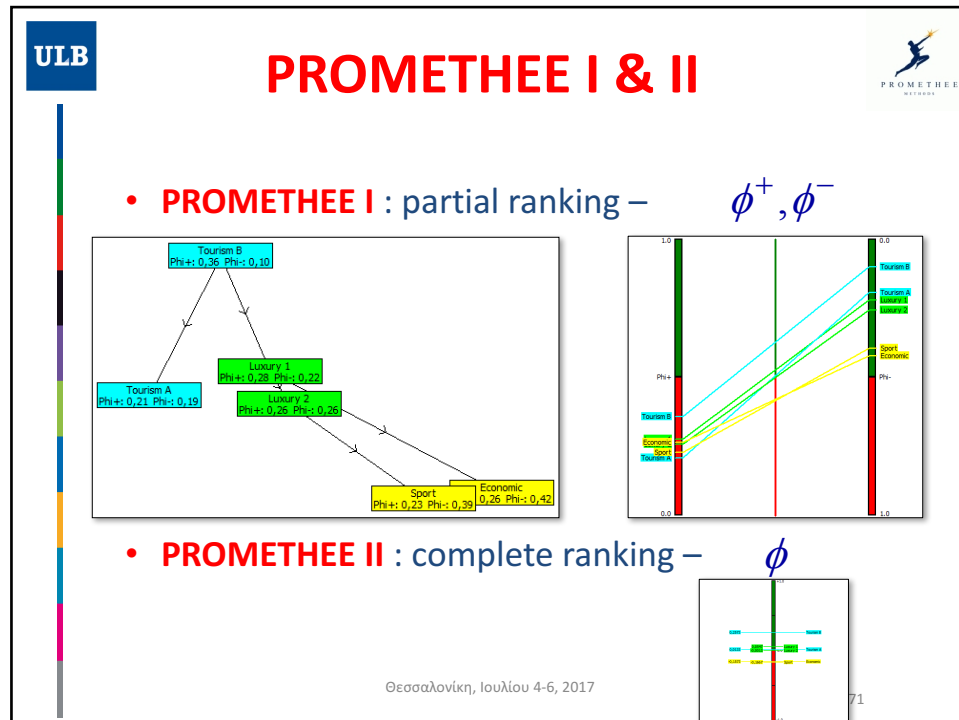
Wednesday 5 The Software



- Advanced features.
- Using **PROMETHEE** and the **Visual PROMETHEE** software.
- Hands-on training.

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Sensitivity Analysis with PROMETHEE

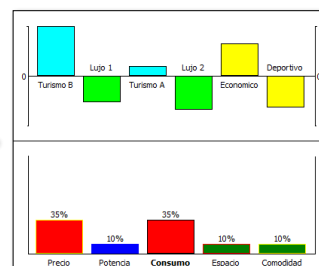
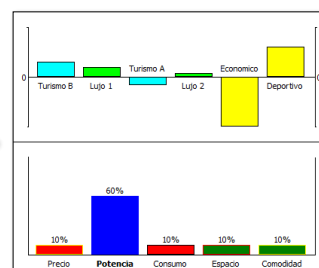
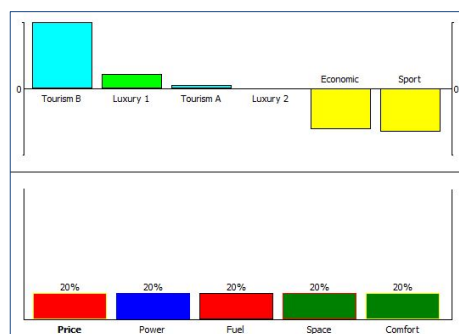


- Criteria weights $\leftrightarrow$ **PROMETHEE** ranking.
- Interactive weight sensitivity analysis:
« Walking Weights ».
- Robustness with respect to weight values?
 - Weight stability intervals.
 - Visual weight stability intervals.

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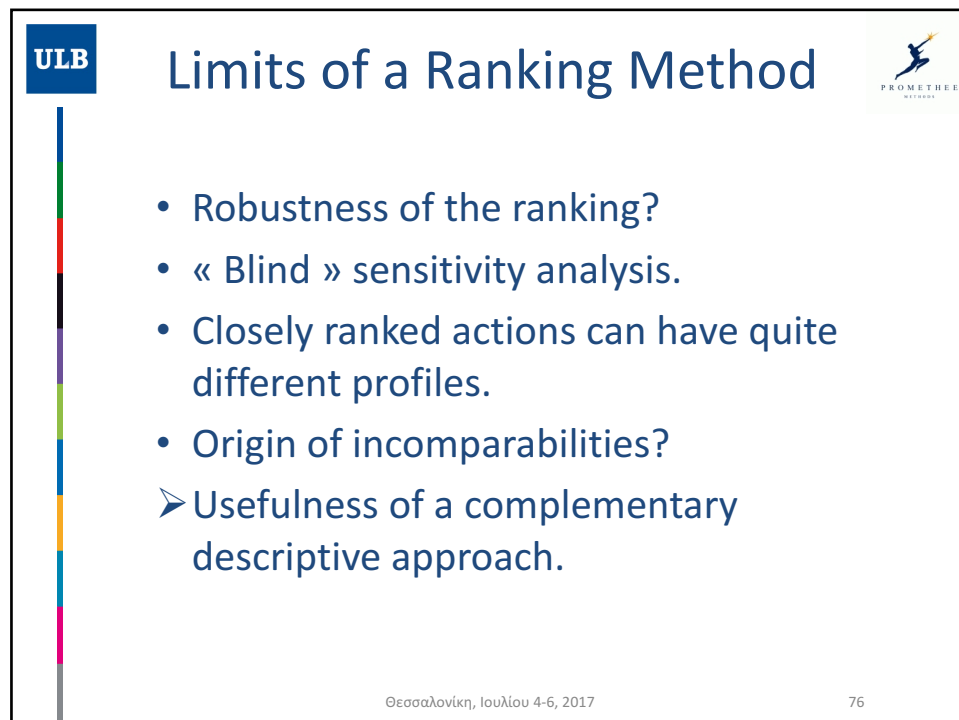
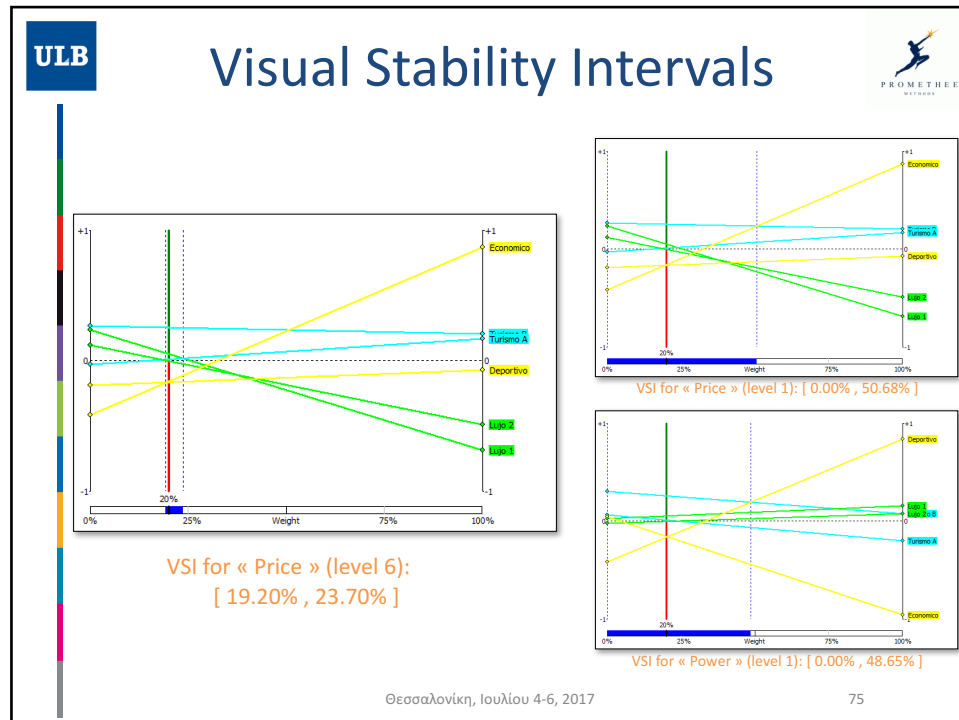
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Walking Weights



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Properties of the Net Flow



- Net flow is centered: $\sum_{a \in A} \phi(a) = 0$

- Unicriterion net flows:

$$\phi(a) = \sum_{j=1}^k w_j \cdot \phi_j(a)$$

with

$$\phi_j(a) = \frac{1}{n-1} \sum_{b \in A} [P_j(a, b) - P_j(b, a)]$$

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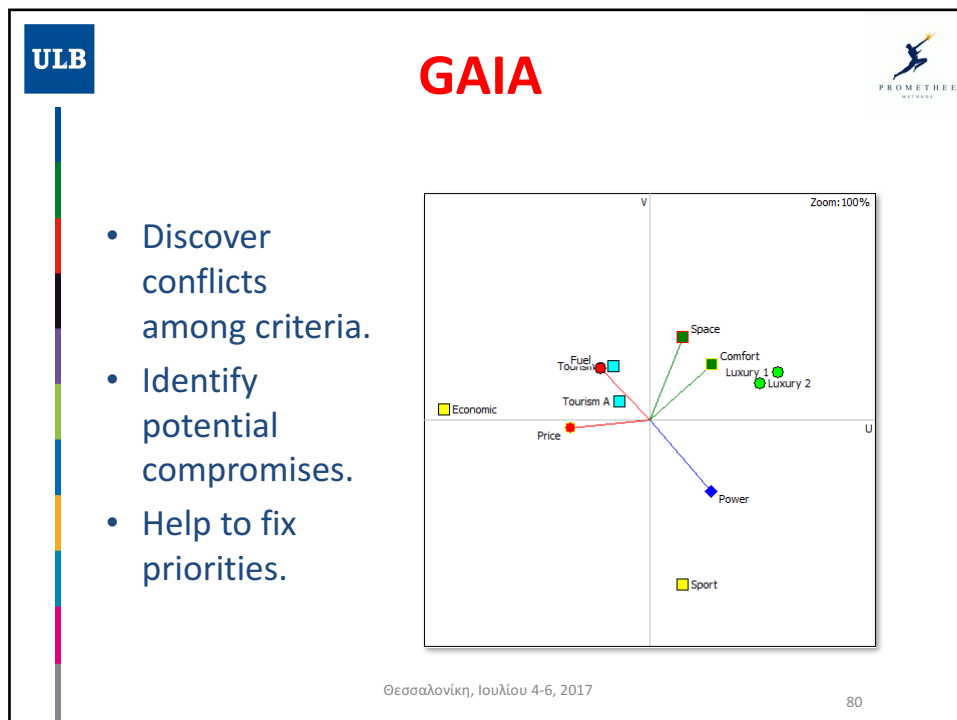
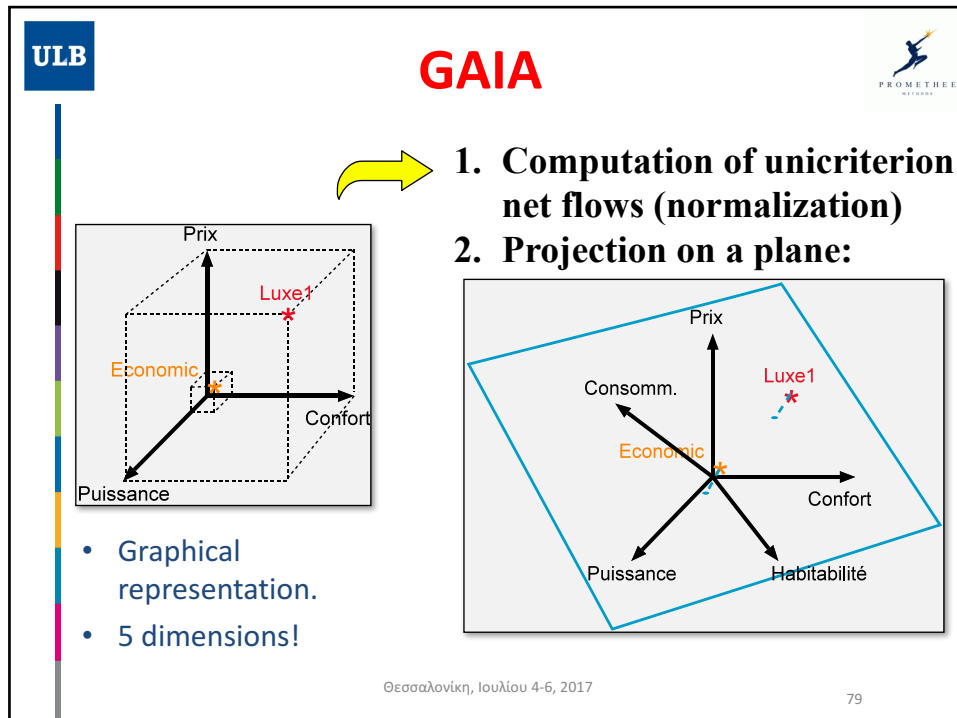
GAIA

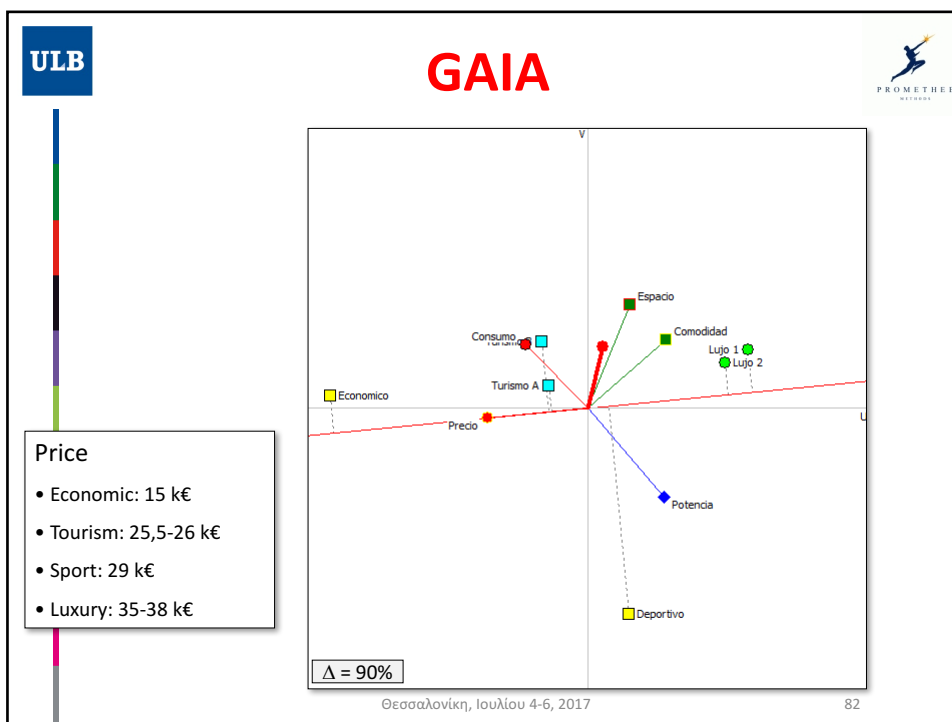
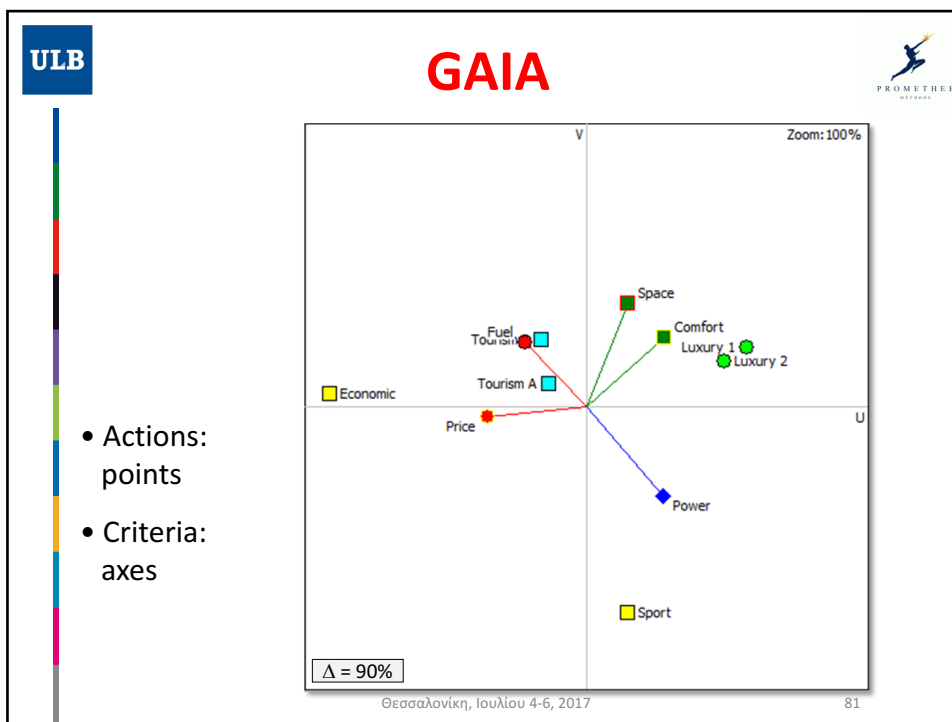


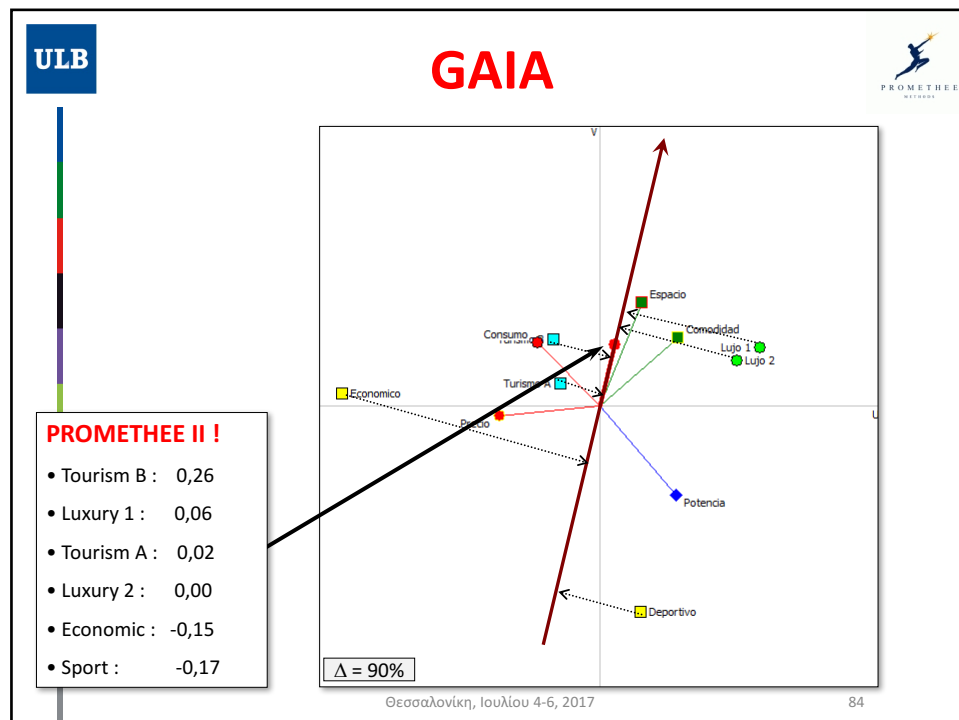
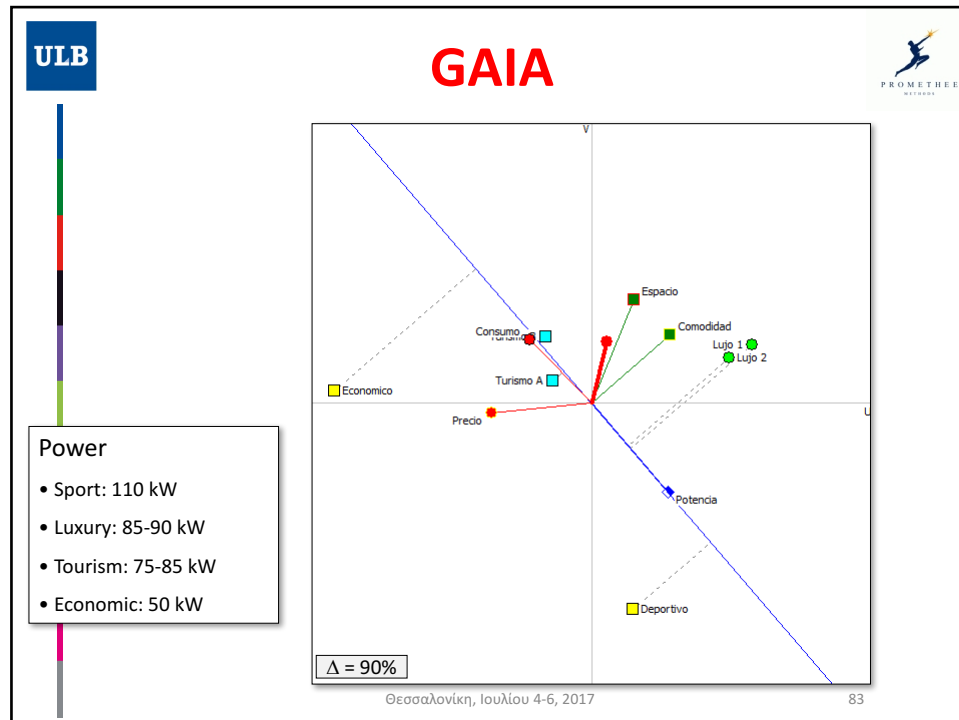
- Visual descriptive analysis.
- Better understanding:
 - Conflicting criteria.
 - Action profiles.
 - Possible compromise solutions.
- Reducing the multicriteria dimension:
 - Principal components analysis.

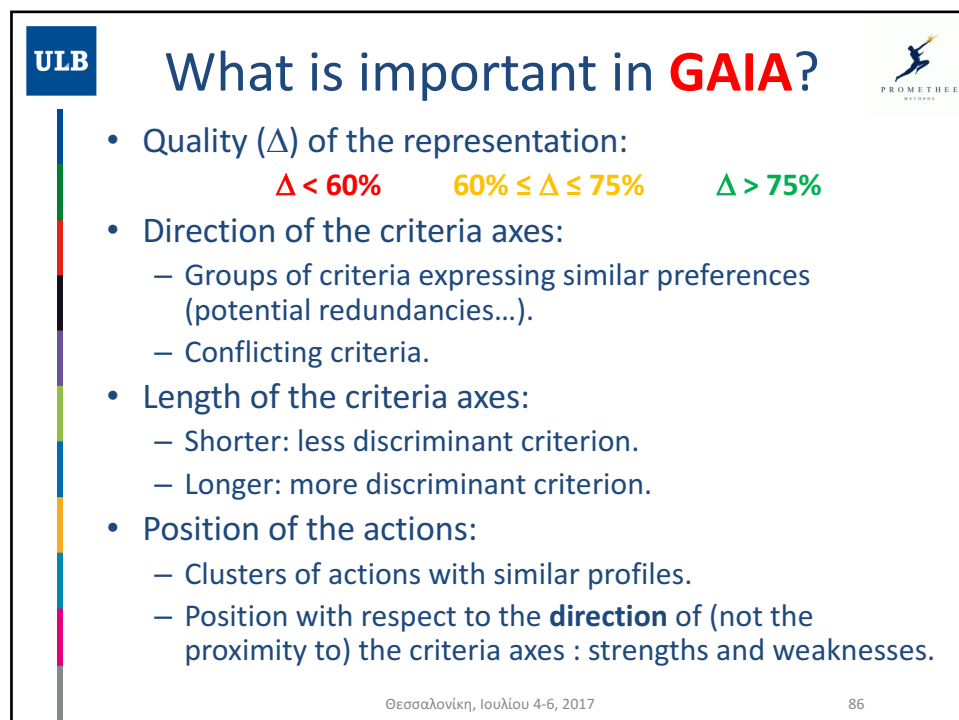
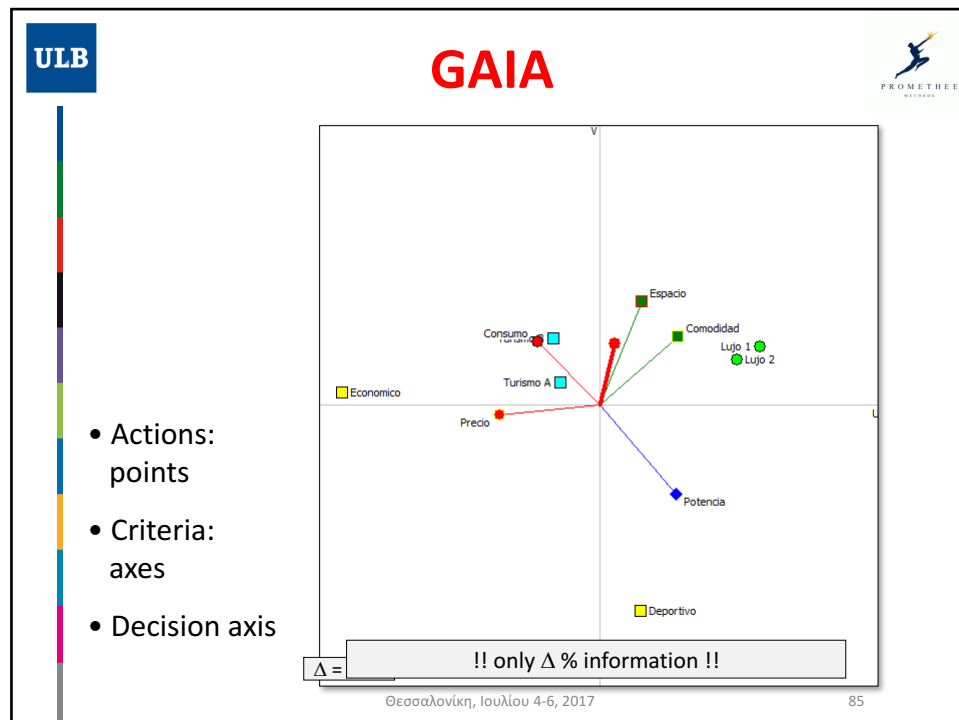
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Sensitivity Analysis with **GAIA**

- Criteria weights $\leftrightarrow$ Decision axis position.
- Interactive weight sensitivity analysis:
« Walking Weights ».
- Robustness with respect to weight values?
 - Decision maker « brain » (**PROMETHEE VI**).
 - Area determined by the tip of the decision axis when criteria weights are changed within predefined percentages.

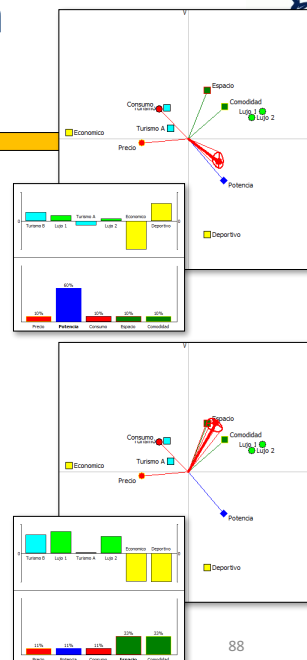
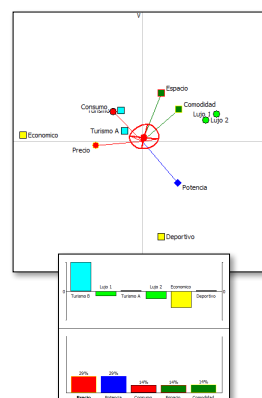
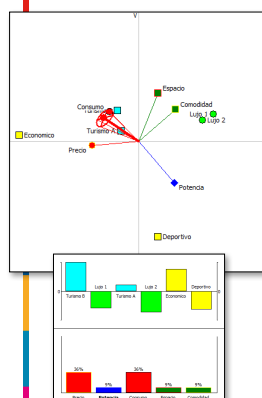
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GAIA-Brain

20 years old

35 years old



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Enhancing **GAIA**

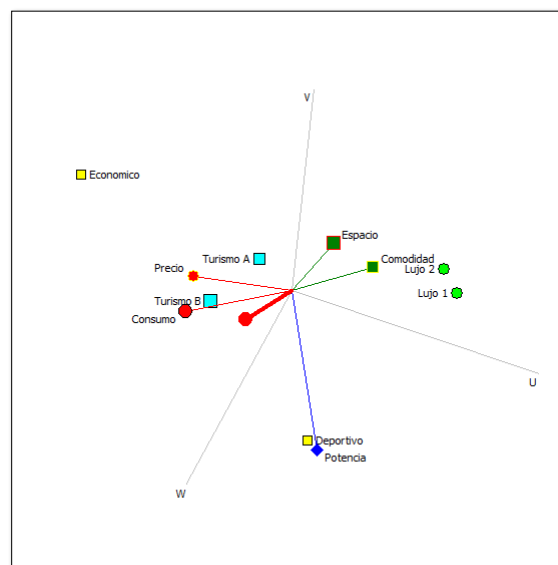


- Limits of **GAIA**:
 - Imperfect view of the multicriteria data ($\Delta\%$).
 - Potential distortion of the action profiles.
 - Non-optimal representation of the decision axis (weights) and distortion of the **PROMETHEE II** ranking (especially when the decision axis is shorter).
- New« **GAIA**-type » views:
 - **GAIA** 3D
 - **GAIA** Webs

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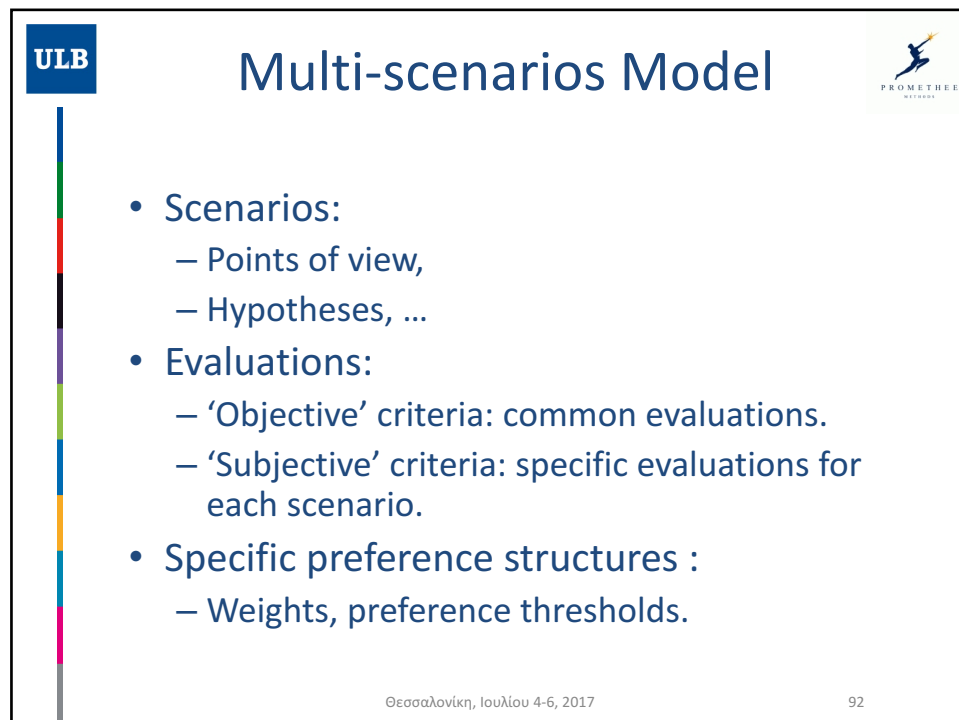
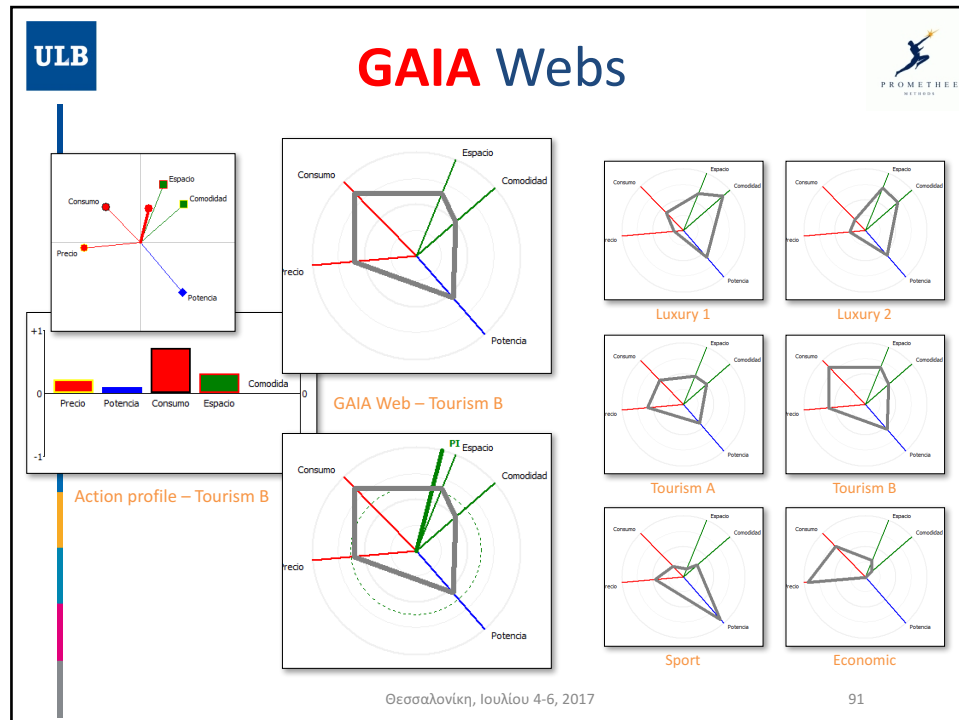
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GAIA 3D



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Multi-scenarios Model



- Adaptation of **PROMETHEE**:
 - Individual rankings,
 - Global (group) ranking with possible weighing of the scenarios.
- Adaptation of **GAIA**:
 - Three different analyses:
 - **GAIA**-Criteria,
 - **GAIA**-Scenarios,
 - **GAIA**-Unicriterion.

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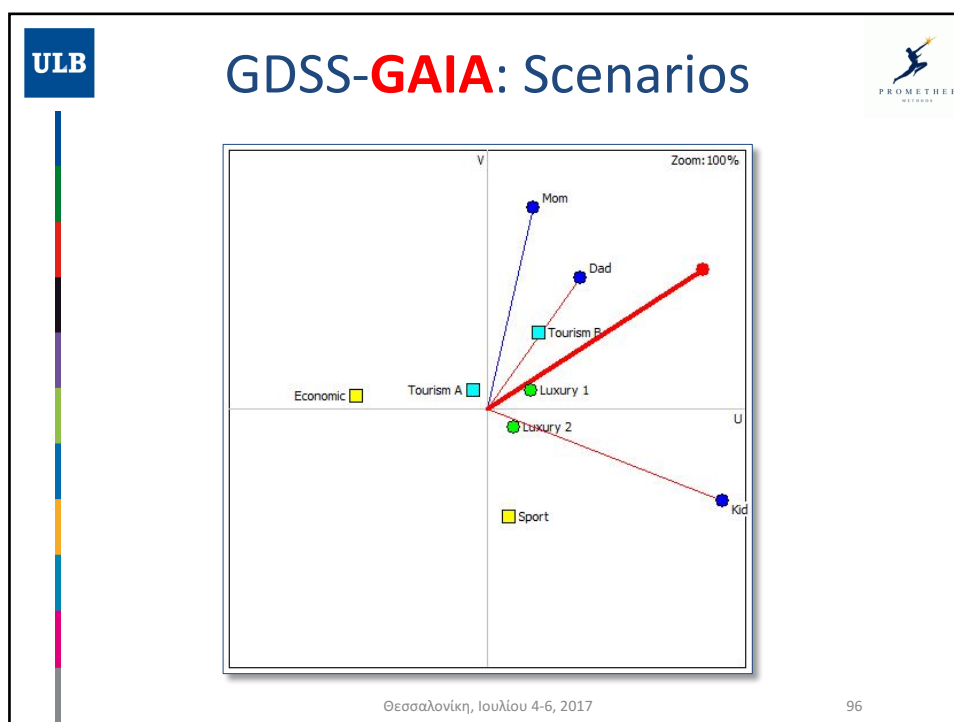
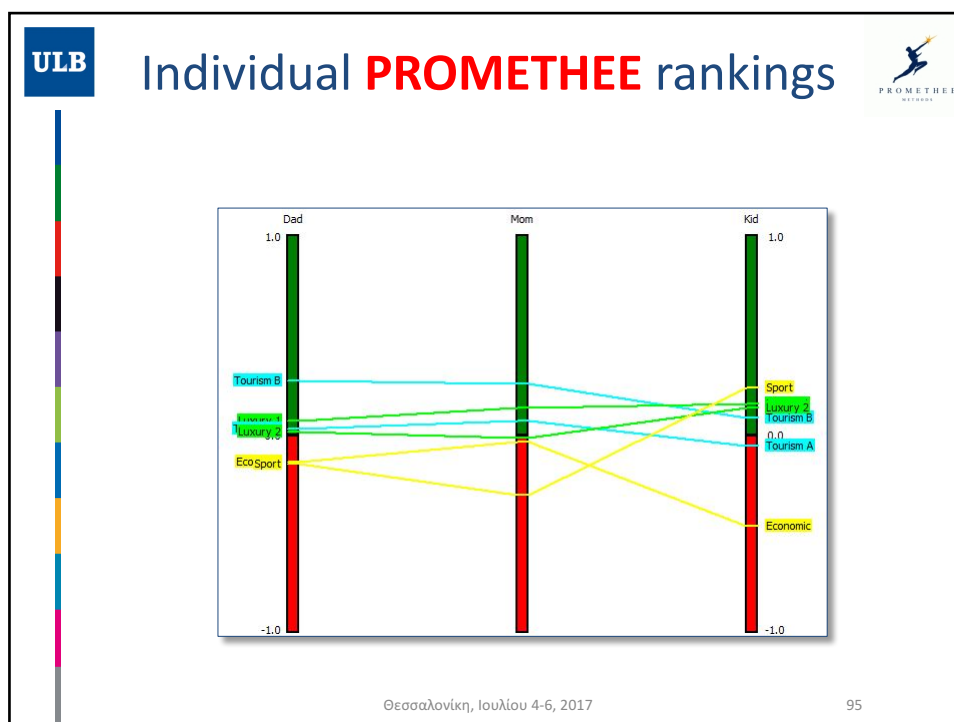
Example

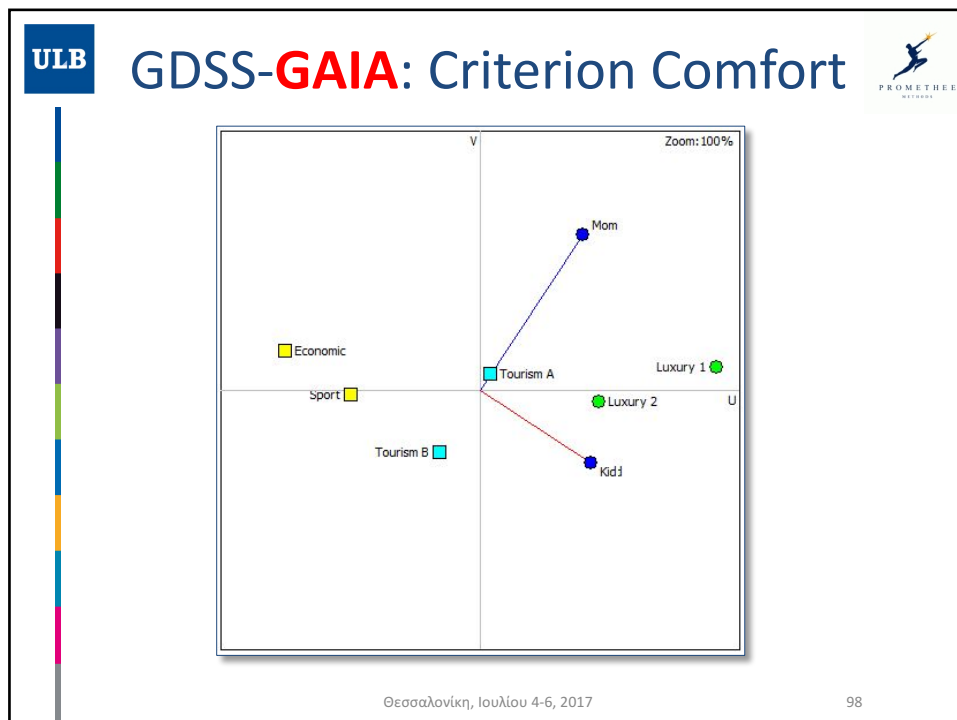
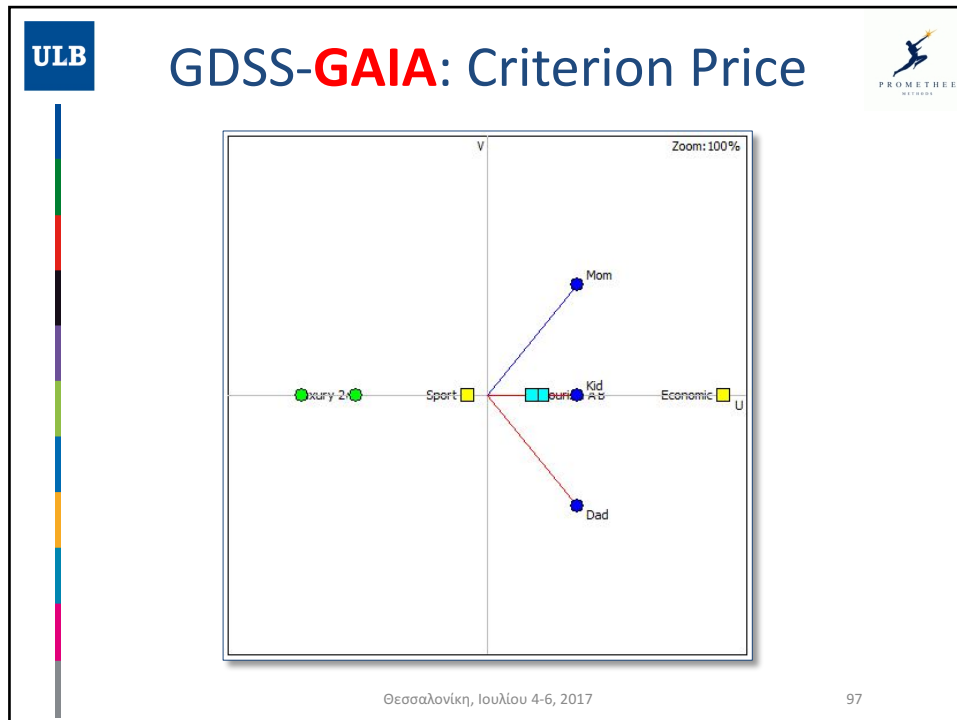


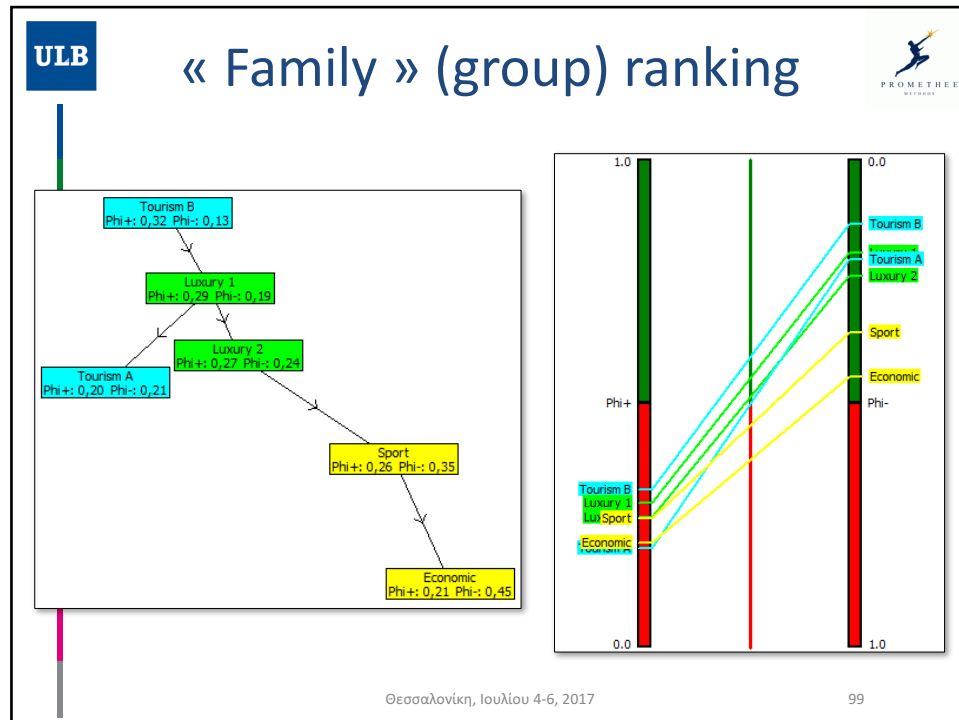
- A Greek family.
- Three actors (“decision makers”):
 - Ιάσων (dad),
 - Ελευθερία (mom),
 - Γιώργος (the kid).
- Three scenarios.
- Three multicriteria tables:
 - Different weights.
 - Subjective evaluation of comfort.

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ULB Other **PROMETHEE** Tools

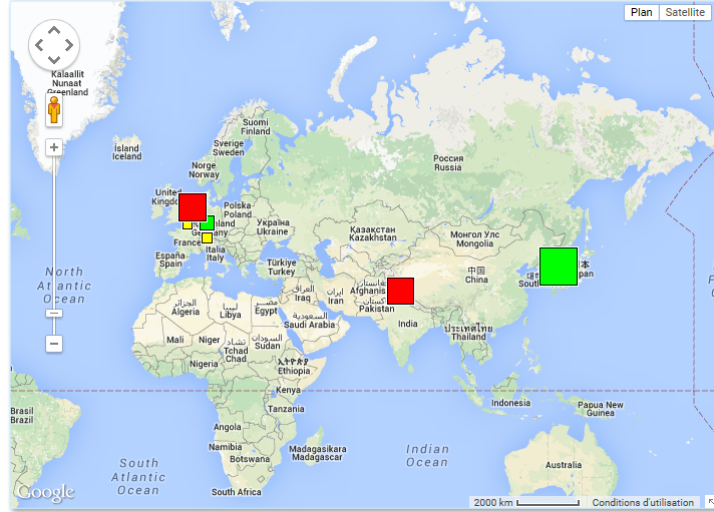
- **PROMETHEE V**
 - Portfolio selection under constraints
- **PROMETHEE Sort**
- Bank Adviser
- **PROMETHEE Efficiency Analysis**
 - Input/output model
- ...

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Google Maps interface





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Homework Assignment



- For Thursday.
- By small groups of 4 to 6 students.
- Set up a multicriteria decision problem:
 - Actual or fictive.
 - Including minimum 6 actions, 5 criteria and 2 scenarios.
 - Prepare the multicriteria evaluation table.
 - Think about preference functions and criteria weights.

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Visual PROMETHEE

WWW.PROMETHEE-GAIA.NET



- **Visual PROMETHEE** software:
 - **Free Academic Edition**
 - **Business Edition**
- <http://biblio.promethee-gaia.net> :
 - Over 1570 references available.
- **Visual PROMETHEE** Manual (PDF or ebook)
- Services: Training, Coaching, Free seminars
- <http://blog.promethee-gaia.net>
- <http://www.promethee-days.com> **Spring 2018**
- LinkedIn group, Twitter, ResearchGate, ...

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Thursday 6

Practice



- Exercises.
- Case studies (homeworks).

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Steps for using **PROMETHEE**

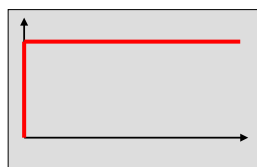


1. Define the actions (list)
2. Define the criteria
 - Quantitative
 - Qualitative (scale)
3. Fill the evaluation table (evaluations).
4. For each criterion:
 - Choose the right type of preference function
 - Set the appropriate thresholds
5. Set the weights of the criteria

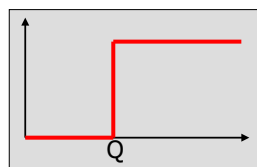
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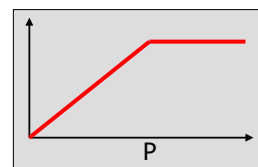
Preference Functions (as in **Visual PROMETHEE** software)



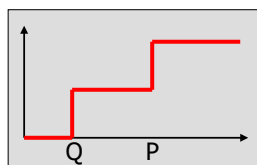
Usual



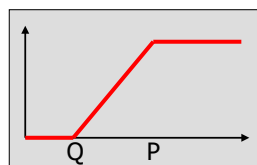
« U » shape



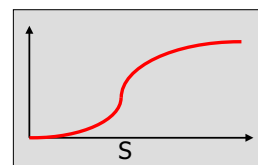
« V » shape



Level



Linear



Gaussian

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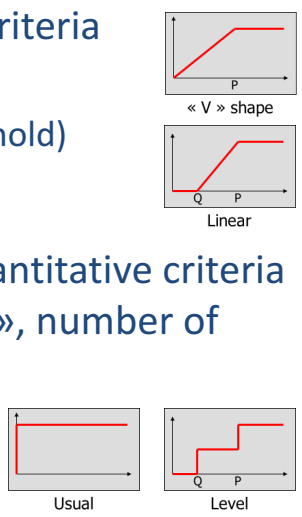


Preference Functions



- For continuous quantitative criteria (e.g. cost, price, power):
 - V-shape (no indifference threshold)
 - Linear

- For qualitative or discrete quantitative criteria (e.g. « very good to very bad », number of USB ports):
 - Usual (no thresholds)
 - Level



« V » shape
Linear
Usual
Level

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Think about...



- Using action categories:
 - To identify similar actions by color.
- Using clusters and groups of criteria:
 - Two-level hierarchy:
 - Clusters are main families of criteria (economy, environment, social, ...),
 - Groups are subsets of related criteria within a cluster (air, water, landscape, ... within environment).
 - Color code.
 - Grouping for easier sensitivity analysis.

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Next...



- **First:** Thanks to all of You!
- **Continue...**
- **Check** <http://www.promethee-gaia.net>
- **Join** **PROMETHEE** methods LinkedIn group
- **Download** **Visual PROMETHEE**
 - Free full-featured **Academic Edition**
- **Interact** with us:
 - **PROMETHEE Academy**
 - **PROMETHEE Days 2018** in Heraklion!
<http://www.prometheedays.com>