ULB

UNIVERSITÉ LIBRE DE BRUXELLES

Solvay Brussels School
Economics & Management

PROMETHEE
METHODS

MultiCriteria Decision Aid with PROMETHEE & GAIA

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

Πανεπιστήμιο Μακεδονίας
Θεσσαλονίκη, May 20-21, 2016

Bertrand MARESCHAL
Solvay Brussels School of Economics & Management
bmaresc@ulb.ac.be
http://www.promethee-gaia.net

ULB

Course Schedule

PROMETHEE
METHODS

- **Friday 20 – What? Why? How?**
  - Morning
    - What is multicriteria decision aid
    - Why you should use multicriteria decision aid
  - Afternoon
    - **PROMETHEE & GAIA**
- **Saturday 21 – Using Visual PROMETHEE**
  - Morning
    - Hands-on training
  - Afternoon
    - Case studies

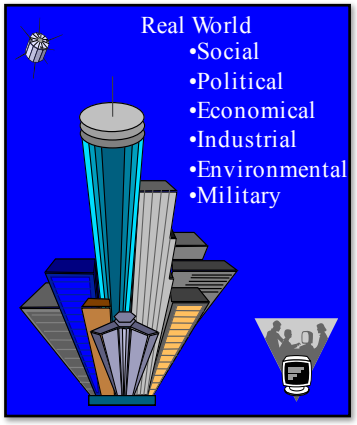
Friday 20 – What? Why? How?

- **Morning**
  - What is multicriteria decision aid
    - Optimization vs multicriteria decision aid
    - Sustainable decisions
    - Models and main approaches
  - Why you should use multicriteria decision aid
    - Facing complexity and conflicting issues
    - Single decision maker context
    - Collaborative group decision
    - Negotiations between parties or stakeholders
- Afternoon
  - **PROMETHEE & GAIA**

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, …

Decision Making

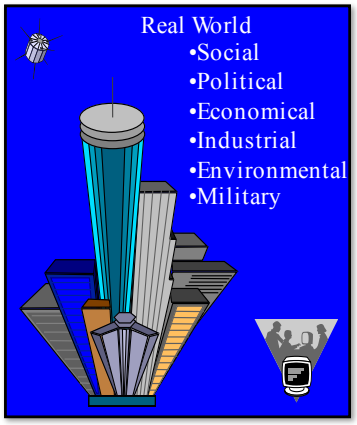


- Describe,
- Understand,
- Manage.

2 Approaches :

- Qualitative approach,
- Quantitative approach.

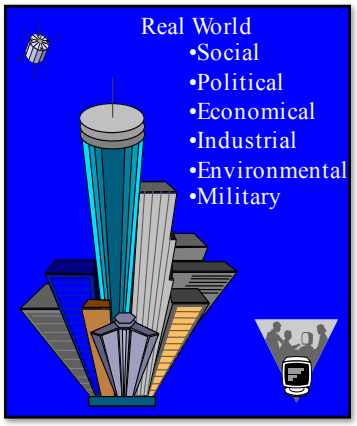
Decision Aid



Quantitative model

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

Decision Aid



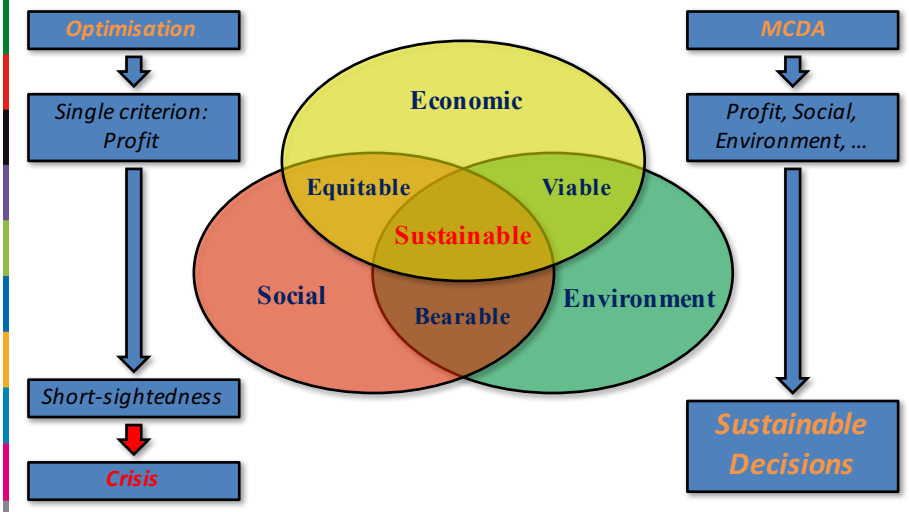
Quantitative model

- Approximation to real world!
- ➢ Decision Aid.

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 (MultiCriteria Decision Aid) models…

MCDA vs Optimisation



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.

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, …

Unicriterion vs Multicriteria Model

- **Multicriteria model:**

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

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

Multicriteria Table

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

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	…
…	…	…	…	…	…

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	…
…	…	…	…	…

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	…
…	…	…	…	…

A Simple Example

The purchase of a new car

Objectives:

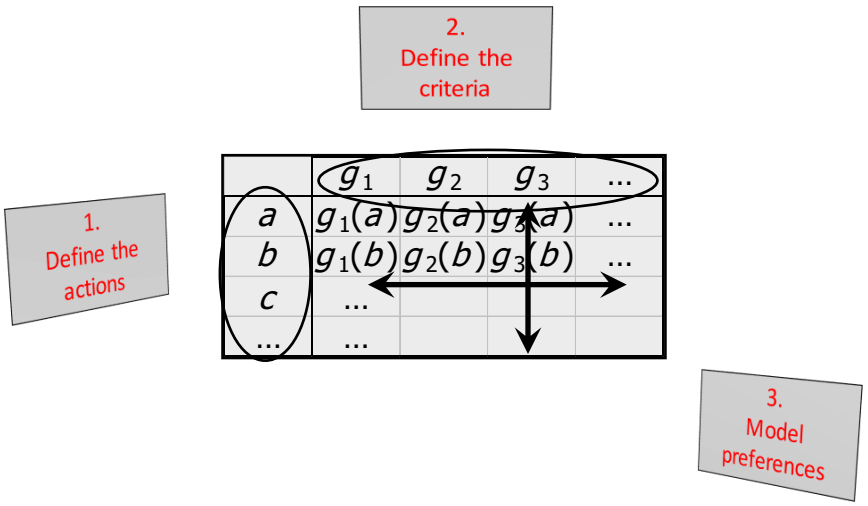
- Economy (price),
- Usage (fuel consumption),
- Performance (power),
- Space,
- Comfort.

Multicriteria Table

Cars	Price	Power	Consumpt.	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?

Modeling… 1… 2… 3…



1. Defining the actions

- 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.

Some properties of the set of actions

A can be:

- **stable**: a priori defined, doesn't evolve.
- **evolutive**: can evolve during the procedure.

- **globalised**: mutually exclusive elements.
- **fragmented**: combinations of actions are considered.

2. Defining the criteria

- Definition:
  function g defined on A, taking its values in a totally ordered set, and representing an objective of the decision-maker.
- Consistent family of criteria:
  - Include all aspects of the decision problem, all the objectives of the decision-maker,
  - Avoid redundancies.

Qualitative Criteria

- Qualitative 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).

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

Traditional preference structure (unicriterion)

- Optimisation of a function g on A

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

- Consequences:

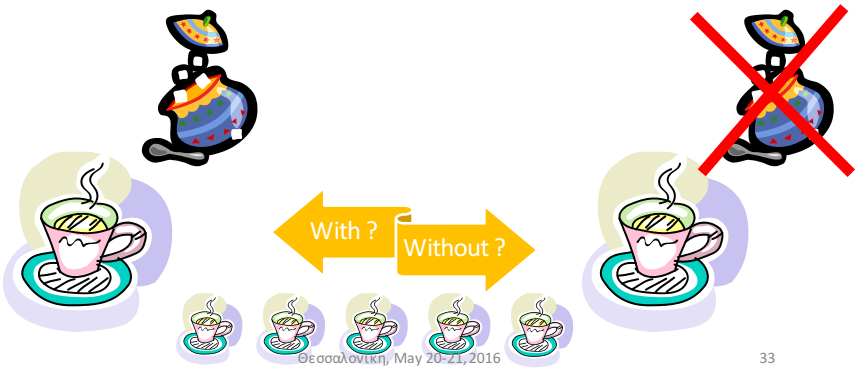
R is empty
P is transitive
I is transitive

- Complete ranking.

The notion of indifference threshold

- Problem: Indifference can be intransitive.

Cf. Coffee cup paradox (Luce, 1956)



The notion of indifference threshold

- Problem: Indifference can be intransitive.
  Cf. Coffee cup paradox (Luce, 1956)
- Introduction of an indifference threshold:

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

- 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.

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.

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”

Multicriteria Model Dominance and efficiency

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

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

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

Objections to Dominance

I	g_1	g_2
a	100	100
b	20	30

- a efficient
- a preferred to b

II	g_1	g_2
a	100	30
b	20	100

- a and b efficient
- a and b incomp.

III	g_1	g_2
a	100	99
b	20	100

- a and b efficient
- a preferred to b

IV	g_1	g_2
a	100	99
b	99	100

- a and b efficient
- a and b indifferent

V	g_1	g_2
a	100	100
b	99	99

- a efficient
- a and b indifferent

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.

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

A common approach:
The weighted sum

- Global value for a :

  $V(a) = w_1\, g_1(a) + w_2\, g_2(a) + \ldots$

- a is preferred to b if:

  $V(a) > V(b)$

  (if all criteria are to maximise)

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.

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.

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" !

Multicriteria Decision Aid

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

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

Multiattribute Utility Theory

- Single synthesis criterion (aggregation).

$$U(a) = U(g_1(a), g_2(a), \text{K}\ , g_k(a))$$

- Existence?
- Construction?
- Mathematical form?

➔ additive?

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

Multiattribute Utility Theory

- Mode of construction :
  - 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

Outranking Methods

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

Friday 20 – What? Why? How?

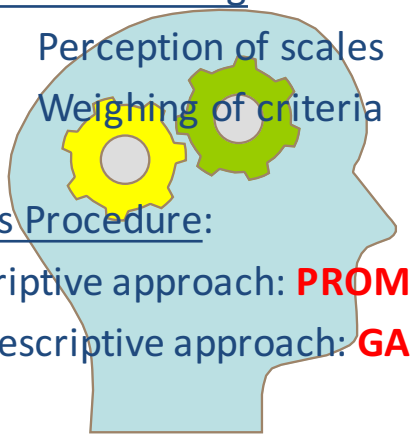
- Morning
  - What is multicriteria decision aid
  - Why you should use multicriteria decision aid
- **Afternoon**
  - **PROMETHEE & GAIA**
    - Data and preference modeling
    - **PROMETHEE** rankings
    - **GAIA** visual analysis
    - Sensitivity analyses
    - Group decision and negotiation

Decision Aid Methods

- Preference modelling:

  Perception of scales

  Weighing of criteria



- Analysis Procedure:

  Prescriptive approach: **PROMETHEE**

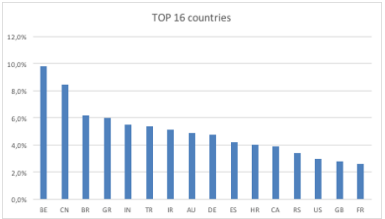
  Descriptive approach: **GAIA**

Why **PROMETHEE**?

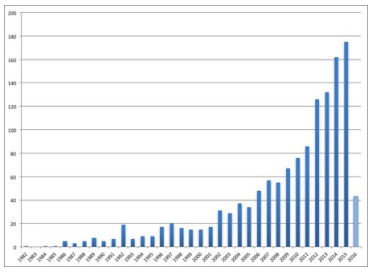
- Proven methodology
  - 30 years development
  - Over 1350 published scientific papers
- « Simplicity »
- Visual tools
- Sensitivity analysis tools
- Interactivity
- **Visual PROMETHEE** software

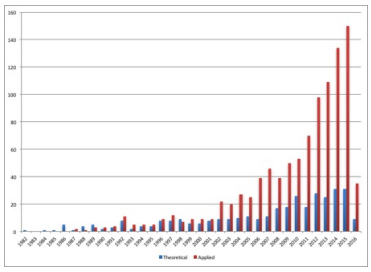
Some stats…

- First paper published in 1982 by J-P. Brans.
- Over 1350 published papers as of today.
- 81 papers published by 140 Greek authors, from 1989 to 2016
  (worldwide #4, after Belgium, China and Brazil)
- Main fields of application:
  - Environment
  - Industry
  - Services / Public sector
  - Energy
  - Finance



PROMETHEE Timeline





- Over 1350 papers published
  - 75% applied – 25% theoretical
- Median year: 2011
- Over 2300 authors from 78 countries

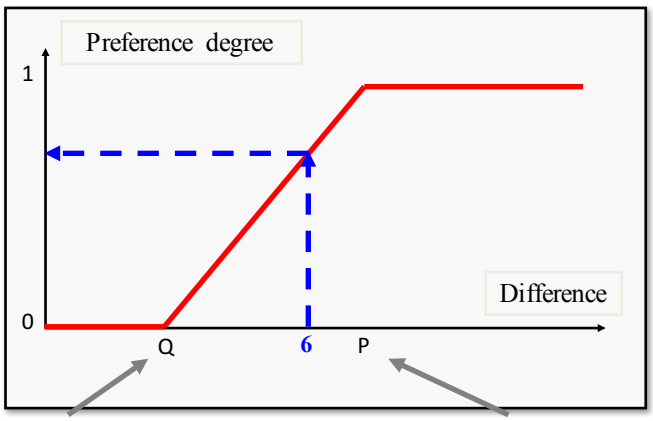
Principles of the PROMETHEE Methods

- Preference modelling:
  - Preference functions
  - Weighing of the criteria
- Pairwise comparison of the actions:
  - Outranking
  - Prudent (partial ranking)
  - Partially compensatory approach
    - Advantage over weighted sum and utility functions

Comparison of 2 Actions

	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	...
...	...	...	...	...	...

Preference Function

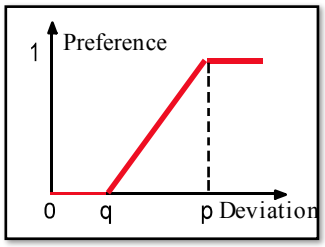


Indifference threshold — Linear — Preference threshold

PROMETHEE

Pref (Eco.,Lux.) **Pref (Lux.,Eco.)**

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

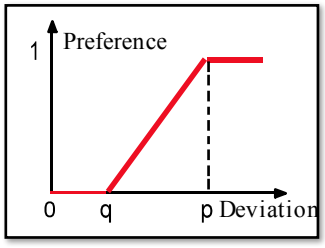


- Pref (Eco.,Lux.) = 0,3
  = (1 + 0 + 0,5 + 0 + 0) / 5
- Pref (Lux.,Eco.) = 0,5
  = (0 + 1 + 0 + 0,5 + 1) / 5

PROMETHEE

Pref (Eco.,Lux.) **Pref (Lux.,Eco.)**

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



- Pref (Eco.,Lux.) = 0,43
  = (2 x 1 + 0 + 2 x 0,5 + 0 + 0) / 7
- Pref (Lux.,Eco.) = 0,36
  = (0 + 1 + 0 + 0,5 + 1) / 7

ULB

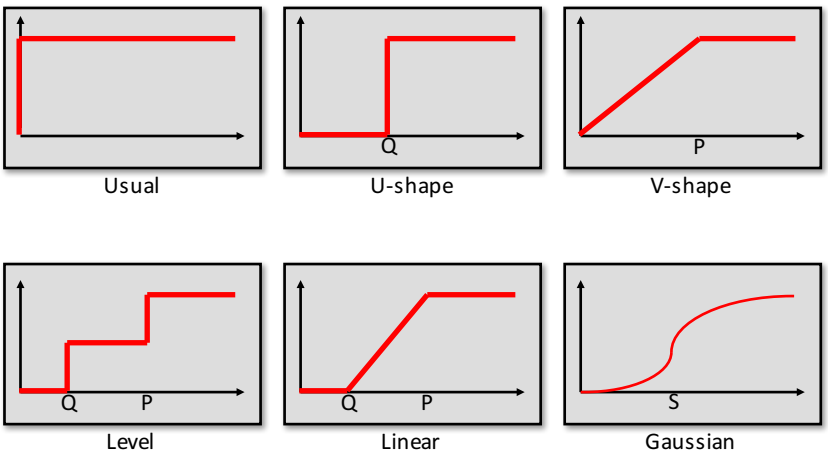
Pairwise Comparisons

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

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

ULB

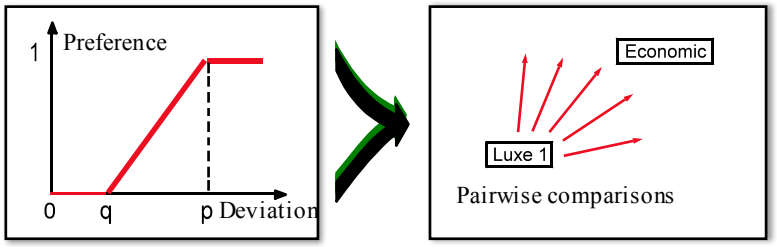
Preference Functions
(as in **Visual PROMETHEE** software)



PROMETHEE

Pref (Eco.,Lux.) **Pref (Lux.,Eco.)**

		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**



Computation of Preference Flows

$\pi(a,b)$	*Tour.A*	*Sport*	*Tour.B*	*Lux.*1	*Econ.*	*Lux.*2	$\phi^+(a)$
Tour.A	0,00	0,34	0,00	0,21	0,26	0,22	0,21
Sport	0,20	0,00	0,16	0,24	0,30	0,24	0,23
Tour.B	0,15	0,55	0,00	0,32	0,45	0,33	0,36
*Lux.*1	0,18	0,45	0,10	0,00	0,50	0,15	0,28
Econ.	0,20	0,34	0,14	0,30	0,00	0,35	0,27
*Lux.*2	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	

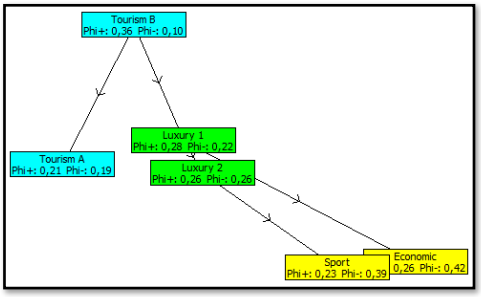
Preference Flows

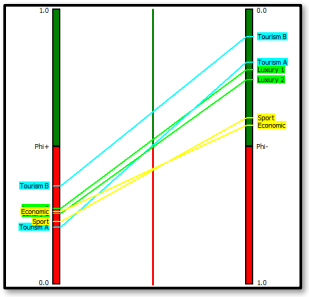
- Relative scores computed for the actions.
- Leaving (+) and entering ( ) flows:
  - Strength: $0 \leq \phi^{+} \leq 1$
  - Weakness: $0 \leq \phi^{-} \leq 1$
- Net flow:
  - Balance: $-1 \leq \phi = \phi^{+} - \phi^{-} \leq +1$
- Unicriterion net flows:
  - Standardized scores for each criterion:

criterion $f_j \Rightarrow -1 \leq \phi_j \leq +1$

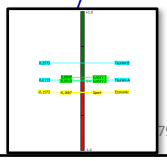
PROMETHEE I & II

- **PROMETHEE I** : partial ranking – ϕ^{+}, ϕ^{-}

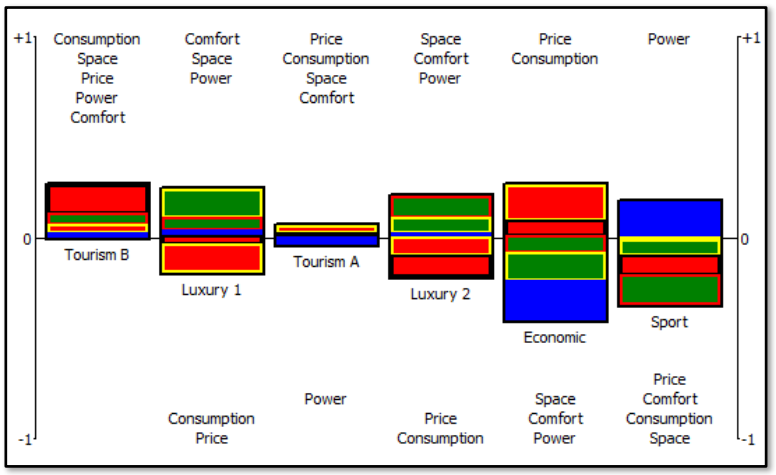




- **PROMETHEE II** : complete ranking – ϕ



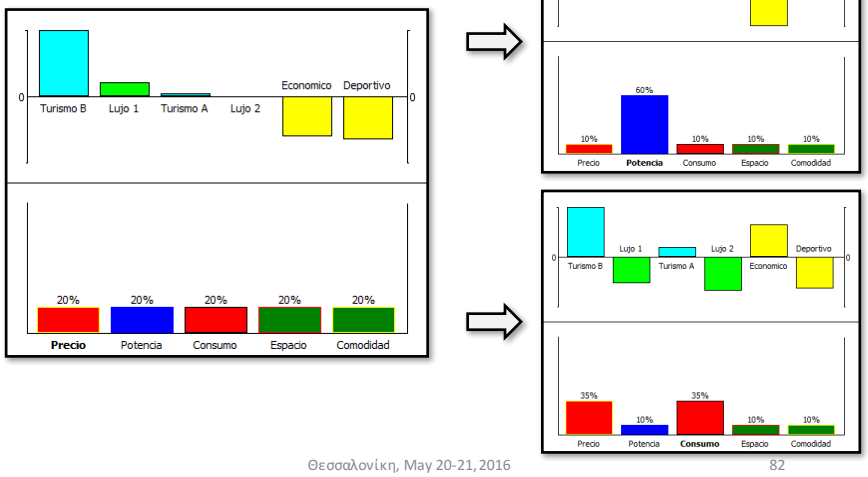
PROMETHEE Rainbow



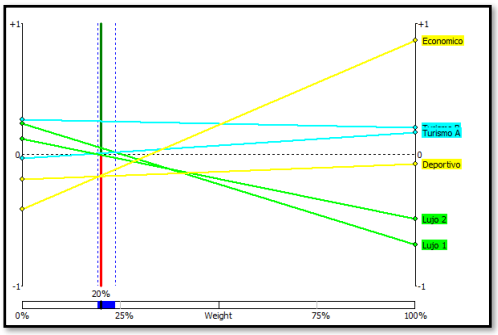
Sensitivity Analysis with PROMETHEE

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

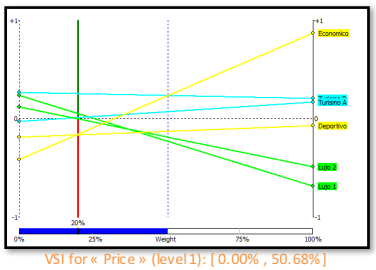
Walking Weights



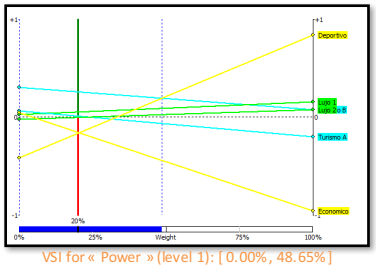
Visual Stability Intervals



VSI for « Price » (level 6):
[19.20% , 23.70%]



VSI for « Price » (level 1): [0.00% , 50.68%]



VSI for « Power » (level 1): [0.00% , 48.65%]

Limits of a Ranking Method

- Robustness of the ranking?
- « Blind » sensitivity analysis.
- Closely ranked actions can have quite different profiles.
- Origin of incomparabilities?

➢ Usefulness of a complementary descriptive approach.

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

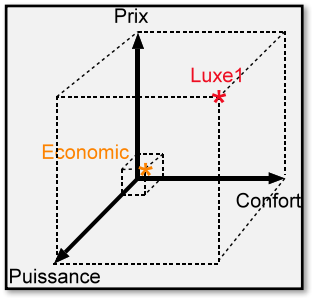
$$\phi_j(a) = \frac{1}{n-1} \sum_{b \in A} \left[P_j(a,b) - P_j(b,a) \right]$$

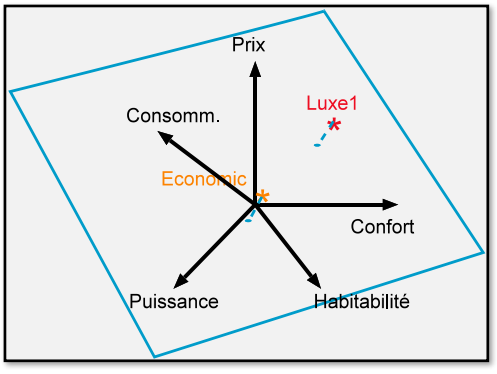
GAIA

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

GAIA

1. **Computation of unicriterion net flows (normalization)**
2. **Projection on a plane:**

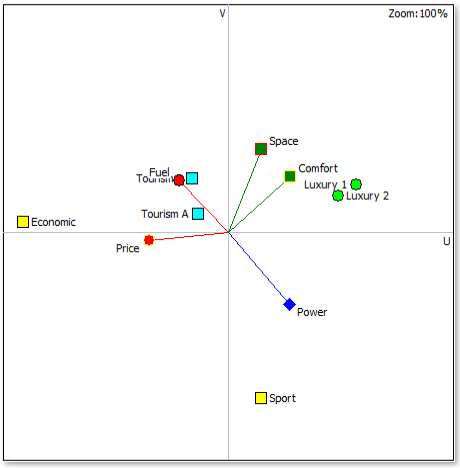




- Graphical representation.
- 5 dimensions!

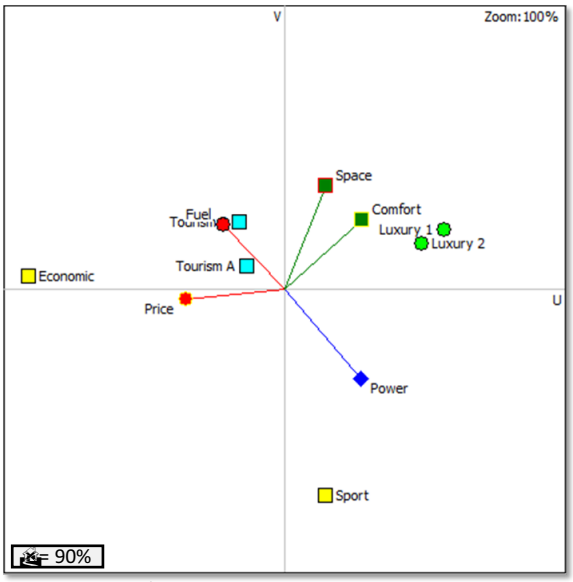
GAIA

- Discover conflicts among criteria.
- Identify potential compromises.
- Help to fix priorities.

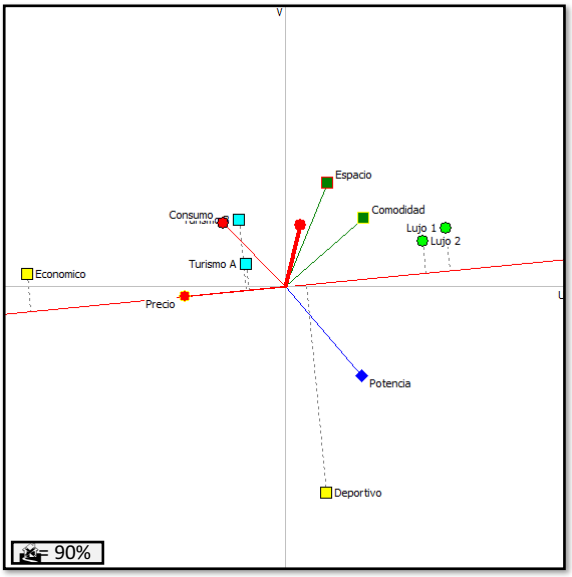


GAIA

- Actions: points
- Criteria: axes

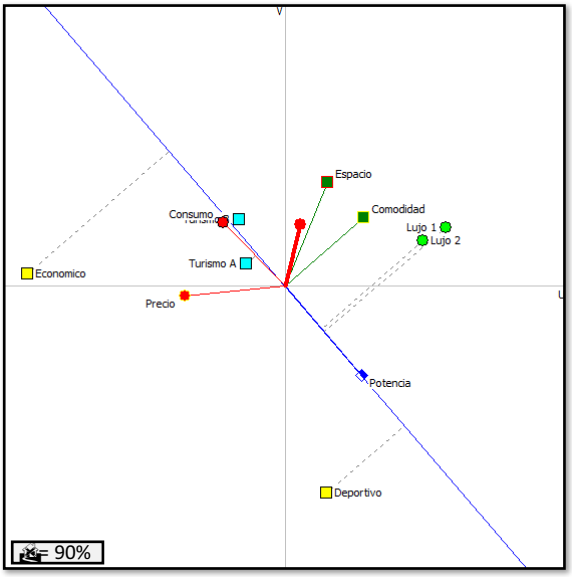


GAIA



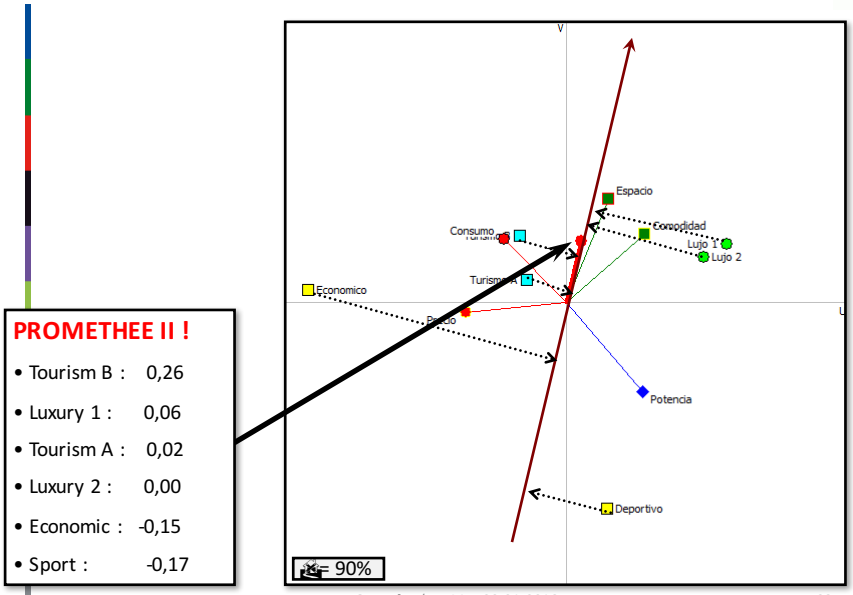
Price
- Economic: 15 k€
- Tourism: 25,5-26 k€
- Sport: 29 k€
- Luxury: 35-38 k€

GAIA



Power
- Sport: 110 kW
- Luxury: 85-90 kW
- Tourism: 75-85 kW
- Economic: 50 kW

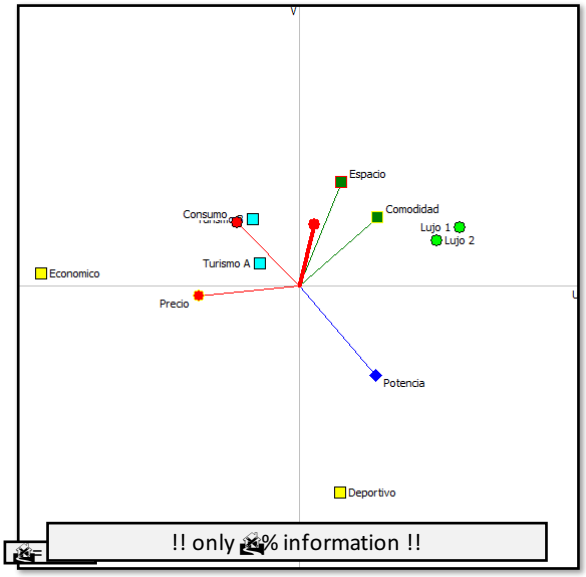
GAIA



PROMETHEE II !

- Tourism B : 0,26
- Luxury 1 : 0,06
- Tourism A : 0,02
- Luxury 2 : 0,00
- Economic : -0,15
- Sport : -0,17

GAIA



- Actions: points
- Criteria: axes
- Decision axis

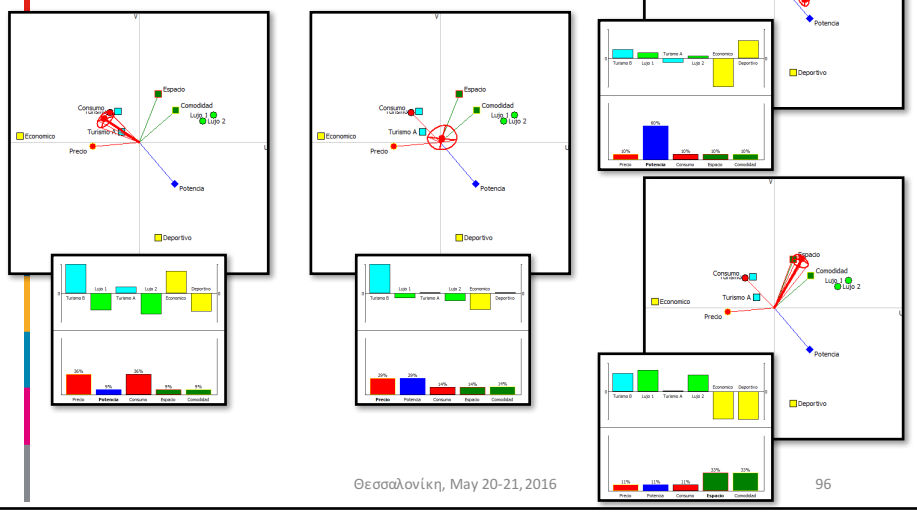
Sensitivity Analysis with GAIA

- Criteria weights ➥ 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.

GAIA-Brain

20 years old

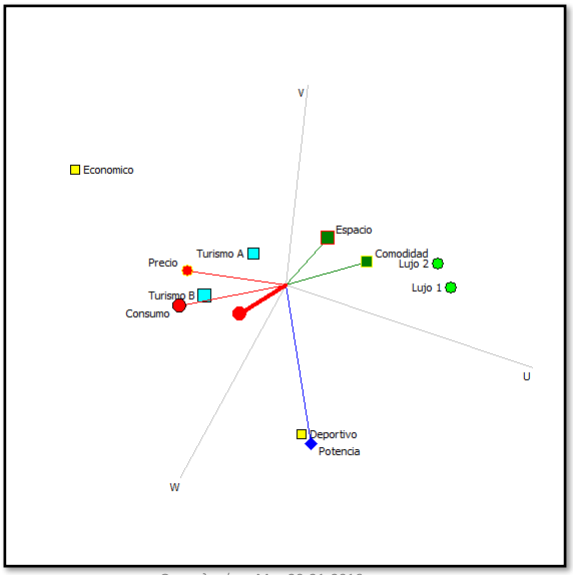
35 years old



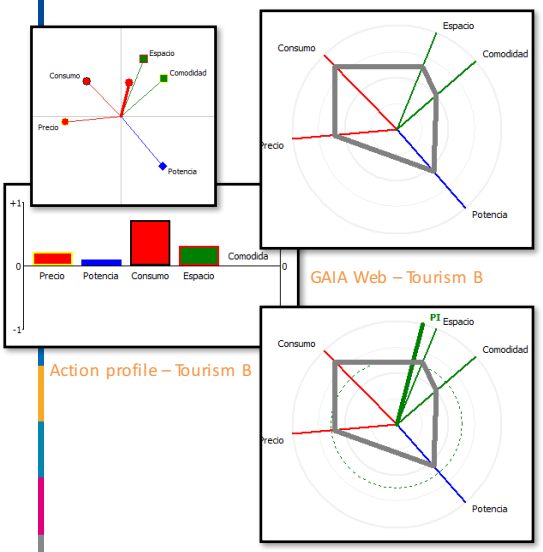
Enhancing GAIA

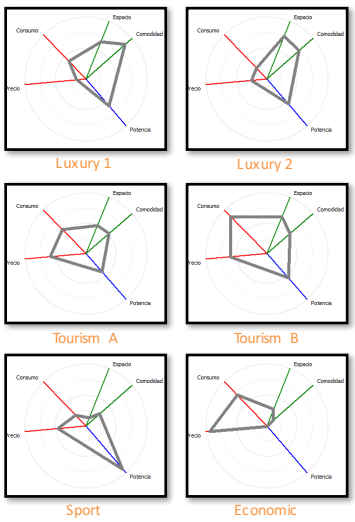
- Limits of **GAIA**:
  - Imperfect view of the multicriteria data (Δ%).
  - Potential distortion of the action profiles.
  - Non-optimal representation of the decision axis (weights) and distortion of the **PROMETHEE II** ranking (especially when the decision axis is shorter).
- New« **GAIA**-type »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

GAIA 3D



GAIA Webs





One or Several Stakeholders ?

- Single stakeholder:
  - One actor (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

Multi-scenarios Model

- Scenarios:
  - Points of view,
  - Hypotheses, …
- Evaluations:
  - 'Objective' criteria: common evaluations.
  - 'Subjective' criteria: specific evaluations for each scenario.
- Specific preference structures :
  - Weights, preference thresholds.

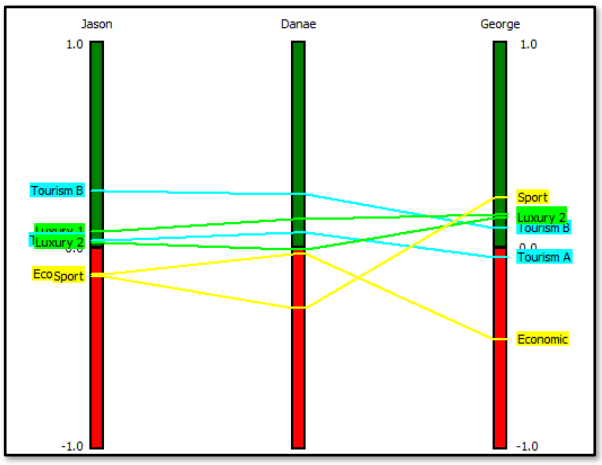
Multi-scenarios Model

- 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

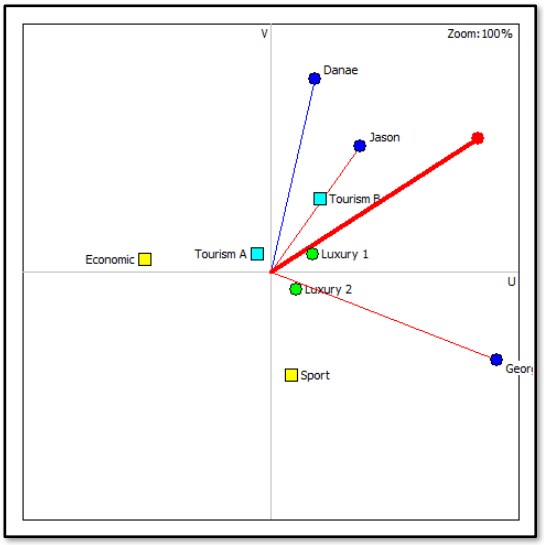
Example

- A Greek family
- Three actors ("decision makers"):
  - Jason (dad),
  - Danae (mom),
  - George (the kid).
- Three scenarios.
- Three multicriteria tables:
  - Different weights.
  - Subjective evaluation of comfort.

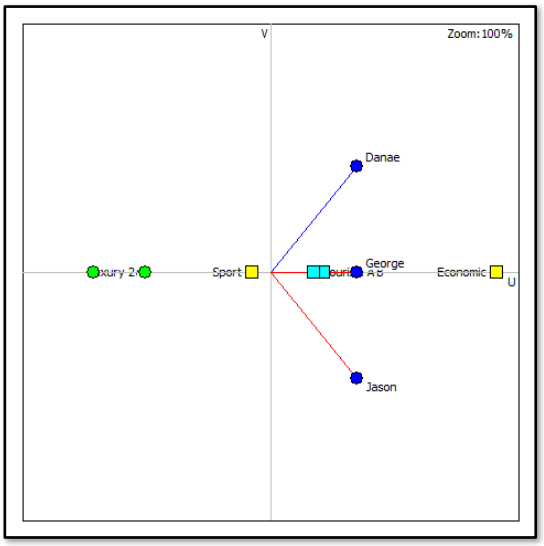
Individual **PROMETHEE** rankings



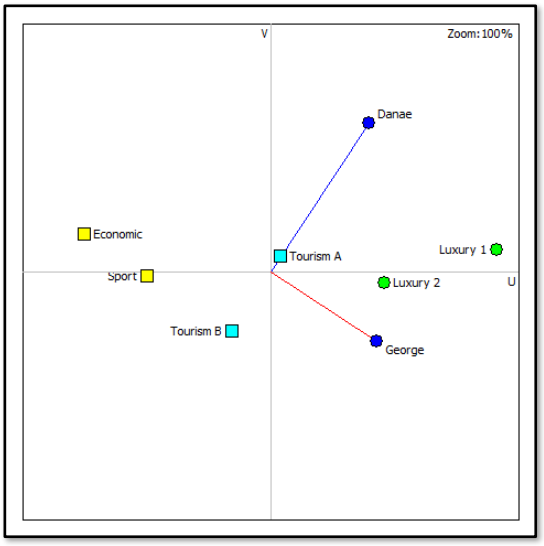
GDSS-**GAIA**: Scenarios



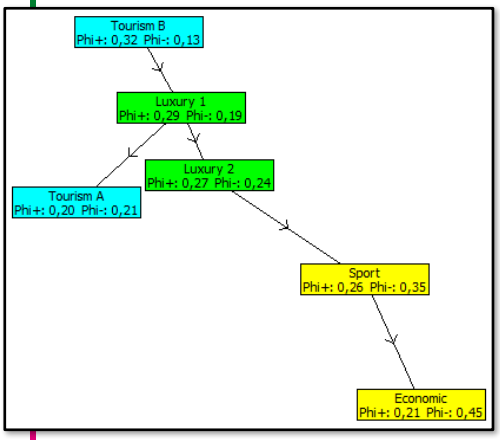
GDSS-**GAIA**: Criterion Price

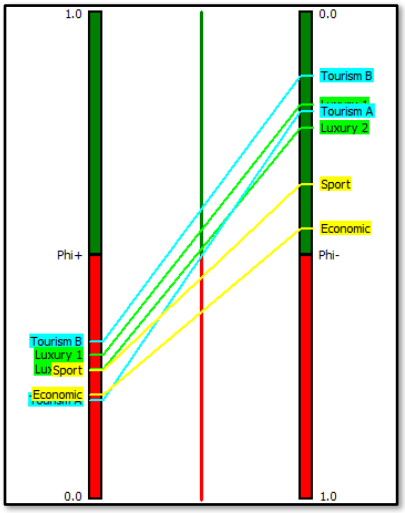


GDSS-GAIA: Criterion Comfort



« Family » (group) ranking

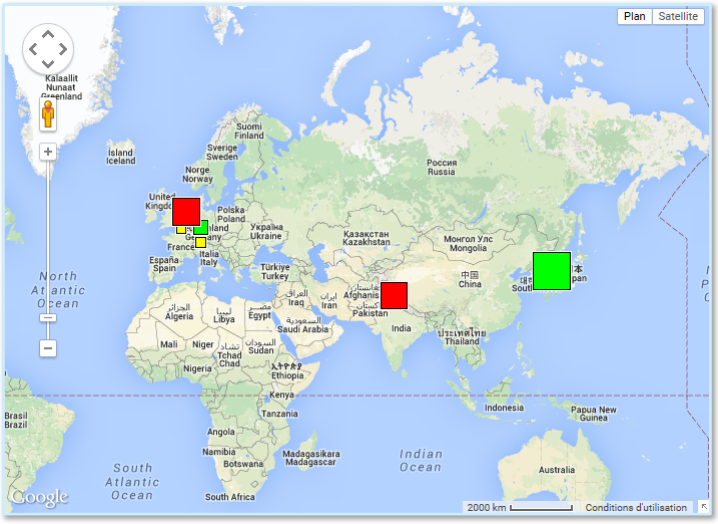




Other **PROMETHEE** Tools

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

Google Maps interface



Homework Assignment

- For tomorrow afternoon.
- 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.

Saturday 20 – Using Visual PROMETHEE

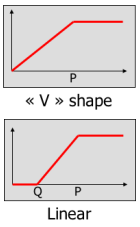
- **Morning**
  - Hands-on training with **Visual PROMETHEE**
    - Learn the software interface
    - Interpret results and displays
    - Practice with simple numerical examples
- Afternoon
  - Case studies

Steps for using PROMETHEE

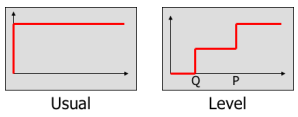
1. Define the actions (list)
2. Define the criteria
   - Quantitative
   - Qualitative (scale)
3. Build the evaluation table.
4. For each criterion:
   - Choose the right type of preference function
   - Set the appropriate thresholds
5. Set the weights of the criteria

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



Visual PROMETHEE

WWW.PROMETHEE-GAIA.NET

- **Visual PROMETHEE** software:
  - **Free Academic Edition**
  - **Business Edition**
- http://biblio.promethee-gaia.net :
  - Over 1350 references
- **Visual PROMETHEE** Manual (PDF or ebook)
- Services: Training, Coaching, Free seminars
- http://blog.promethee-gaia.net
- http://www.promethee-days.com Spring 2017
- LinkedIn group, Twitter, ResearchGate, …

Saturday 20 – Using Visual PROMETHEE

- Morning
  - Hands-on training with **Visual PROMETHEE**
    - Learn the software interface
    - Interpret results and displays
    - Practice with simple numerical examples
- **Afternoon**
  - Case studies