PROMETHEE

METHODS

ULB

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Solvay Brussels School
Economics & Management

Sustainable decisions with multicriteria decision aid: An ethical issue.

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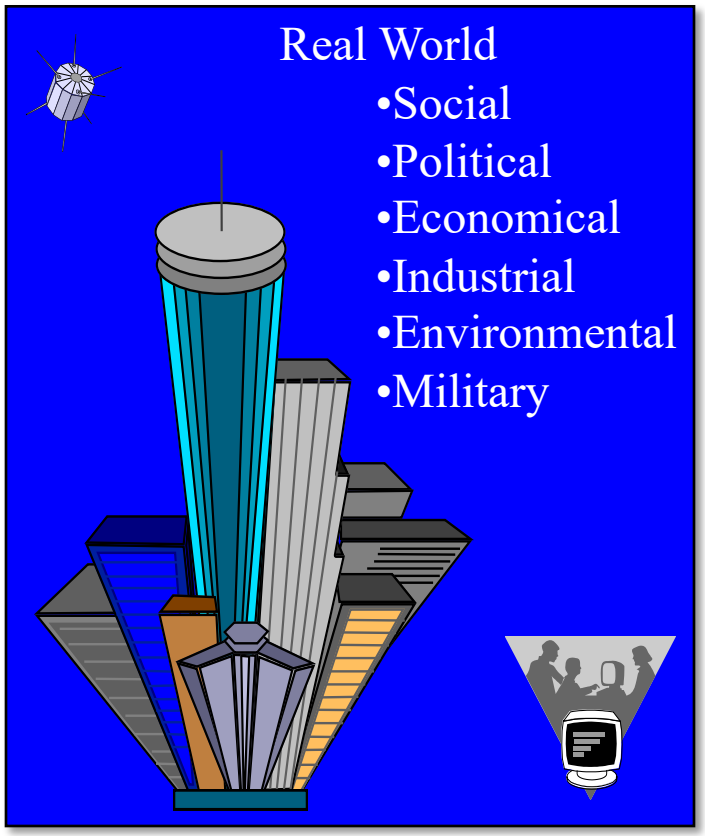
Summary

- Decisions
- Decision Aid
- Multicriteria Decision Aid vs Optimization
- Ethics
- MCDA & Ethics
- The PROMETHEE Solution
- What's next?

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

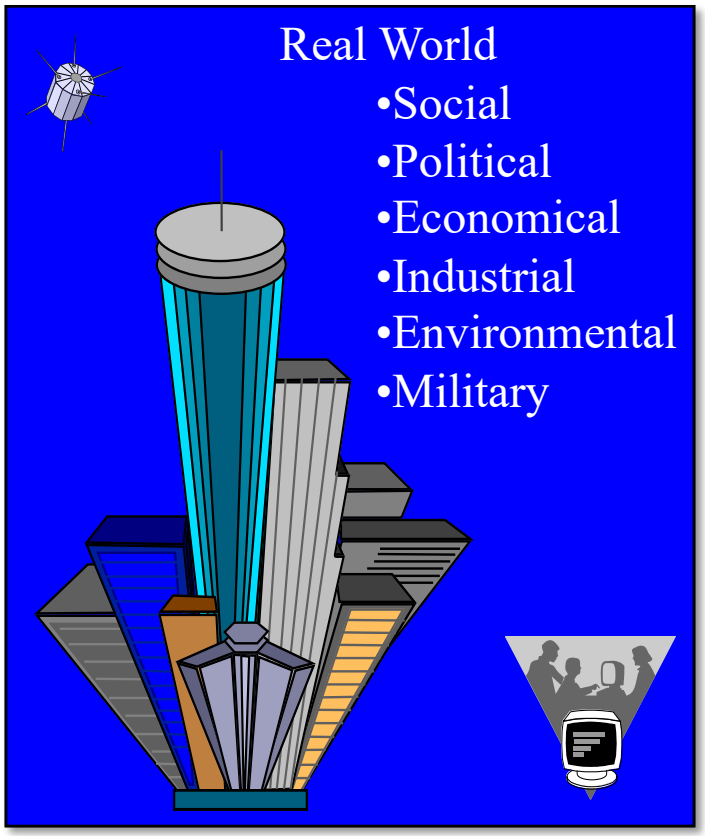


- Describe,
- Understand,
- Manage.

2 Approaches :

- Qualitative approach,
- Quantitative approach.

Decision Aid



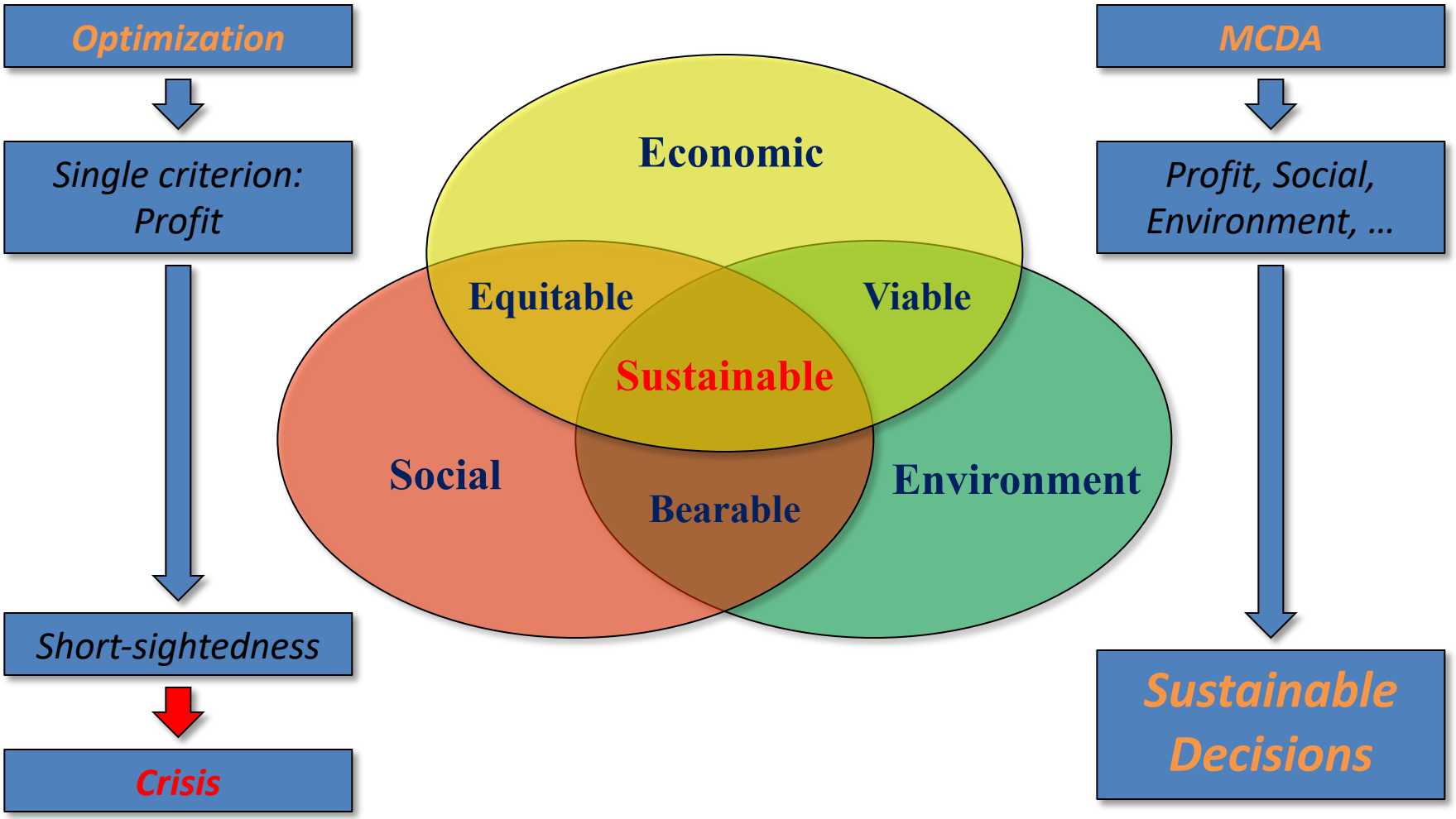
Quantitative model

- 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 Optimization



Dictionary definition

ethics

[**eth**-iks]

Noun

1.(*used with a singular or plural verb*) a system of **moral principles**: *the ethics of a culture.*

2.(*used with a plural verb*) the **rules of conduct** recognized in respect to a particular class of human actions or a particular group, culture, etc.: *medical ethics; Christian ethics.*

3.(*used with a plural verb*) moral principles, as of an individual:

His ethics forbade betrayal of a confidence.

& Decision?

Dictionary definition

decision

[dih-**sizh**-*uh* n]

Noun

1.the act or process of deciding; determination, as of a question or doubt, by **making a judgment**:

They must make a decision between these two contestants.

2.the act of or need for making up one's mind:

This is a difficult decision.

3.something that is decided; **resolution**:

She made a poor decision when she dropped out of school.

4.a judgment, as one formally pronounced by a court:

It is the decision of this court that the appeal is granted.

5.the quality of being decided; firmness:

He spoke with decision and calm authority.

6.the final score in any sport or contest:

The decision was 5 to 4 in favor of the home team.

Ethics

- Has evolved over time:
  - Slavery has been OK in the US until 1865.
  - Universal Declaration of Human Rights in 1948.
- Today includes:
  - Social issues.
  - Environmental issues.
  - Sustainable development for the future of Earth.

Our World Today

- **Positive**
  - Many improvements to global well-being:
    - Healthcare, Mobility, Education, IT, …
- **Negative**
  - Public and private corruption:
    - Lack of morality.
    - Personal vs collective interest.
  - Disconnection between people and politicians:
    - Yellow jackets in France.
    - Rise of populism in Europe and in America.
    - Rise of extremism, nationalism, racism, intolerance, …
  - Greed, egoism.
  - Increasing gap between the poor and the rich.
- **Increasing lack of ethics**

Action is needed to avoid chaos!

- **Our place as OR people?**

Ethics and OR people

- **Is optimization ethical?**
  - Focusing on a single objective? (profit, costs, …)
  - Neglecting all other dimensions of our world?
  - Is it moral?
- **Is Ethics an important issue for OR people today?**
  - Yes! Because we have an impact on decision-makers and on decisions.
- **Can we help?**
  - Yes we can!
- **How can we help?**
  - Education
  - Decision aid

Ethics and Education

- **Education** is **central** as it provides youth with:
  - **Science**: to understand and manage our world.
  - **History**: to avoid repeating past mistakes.
  - **Critical mind**: to avoid populism and fake news.
  - **Civil rights and duties**: to avoid racism and egoism.
  - **Languages**: to understand other people.
- **Education** should bring:
  - **Knowledge**: to make thinkers and creators,
  - More than **Know-how** that makes executants.
- **Education** today has to **shift towards** more **knowledge** and better balanced ethical values.

Ethics and Us

- **OR people** are teaching and are advising decision-makers as well:
  - OR people **have important responsibilities**.
- **OR** started in 1937:
  - Optimization models have been acceptable until the first oil crisis in 1973.
  - From 1973, many things have **changed**:
    - Sky is no longer the limit according to the availability of non-renewable resources such as oil.
    - Environmental issues must be taken into account.
    - Social issues (unemployment) are important.
    - Sustainable development is essential to our survival.

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.
  - Ethics is lacking.

- How can we face it?
  - Think ethical.
  - Share. React. Act.
  - Need for multicriteria approaches to avoid subjectivity and unethical behavior.

Some Examples: 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…

A Simple Example

The purchase of a new car by a Greek family

Objectives:

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

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?

Multicriteria Table

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- Best buy?
- Best compromise ?

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

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”):
  - dad,
  - mom,
  - the kid.
- Three scenarios.
- Three multicriteria tables:
  - Different priorities.
  - Subjective evaluation of comfort.

Common approaches

- Weighted sum
  - Completely compensatory (averaging).
  - Scale normalization problems.
  - Loss of information:
    - Multicriteria → unicriterion optimization.
- MAUT (multi-attribute utility theory)
  - Still completely compensatory logic.
  - Utility function:
    - Existence?
    - Building procedure?

Outranking Methods

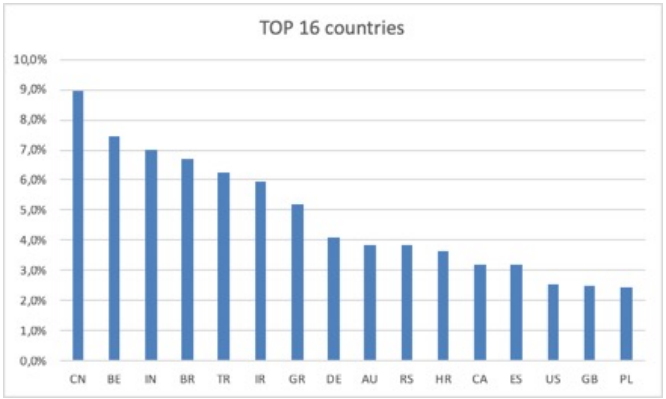
- Majority principle.
- Pairwise comparison of actions.
- Closer to the decision problem.
- Partially compensatory approach.
- **ELECTRE** methods (1968-).
- **PROMETHEE & GAIA** methods (1982-).

Why **PROMETHEE**?

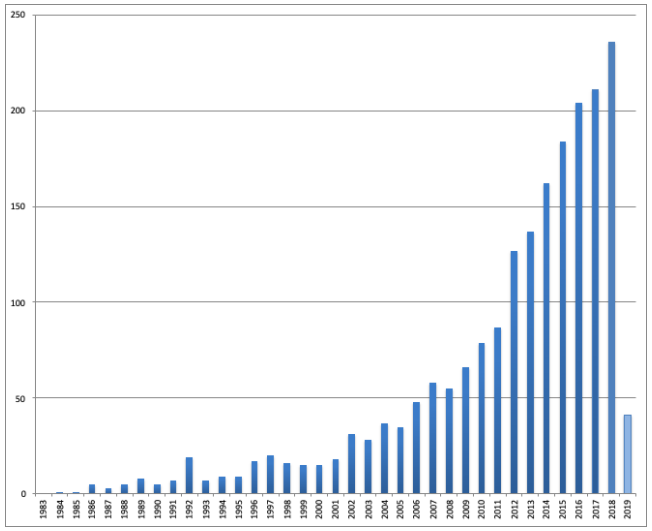
- Proven methodology:
  - 30+ years development,
  - Over 2000 published scientific papers.
- « Simplicity ».
- Visual tools.
- Sensitivity analysis tools.
- Interactivity.
- **Visual PROMETHEE** software.

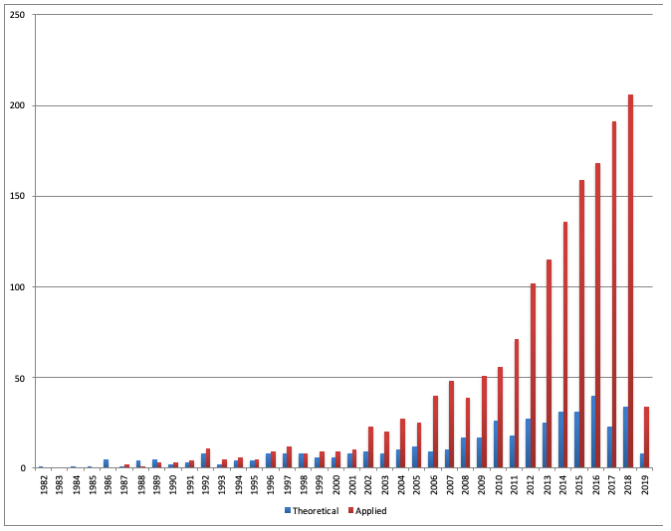
Some statistics…

- First paper presented in 1982 by J-P. Brans.
- Over 2000 published papers as of today.
- 31 papers published by 37 authors from Taiwan, from 1992 to 2019.
  (worldwide #20, after PRC, Belgium, India, Brazil, Turkey, Iran, Greece, Germany, Australia, Serbia, Croatia, Canada, Spain, USA, UK, Poland, … ; #14 PPM)
- Main fields of application:
  - Environment
  - Industry
  - Services / Public sector
  - Energy
  - Finance



PROMETHEE Timeline

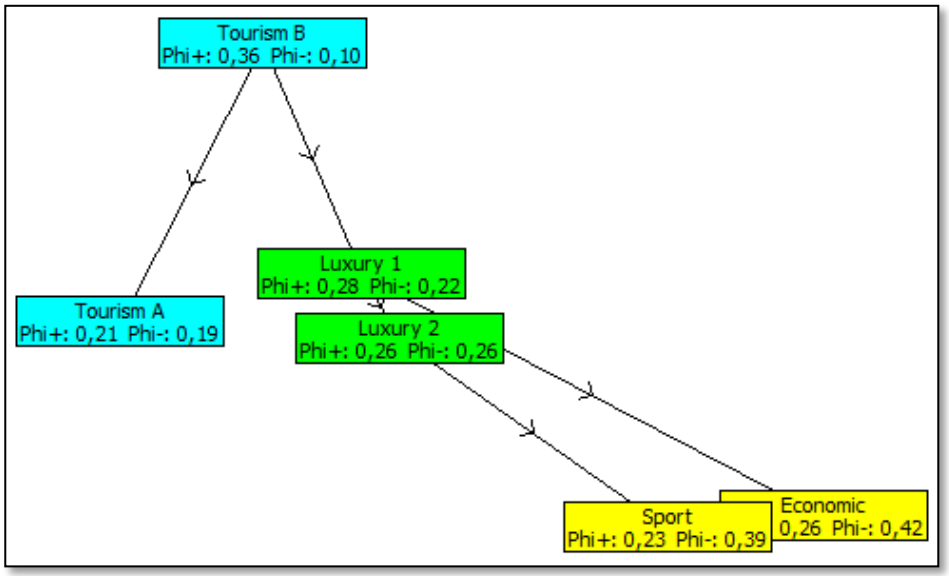


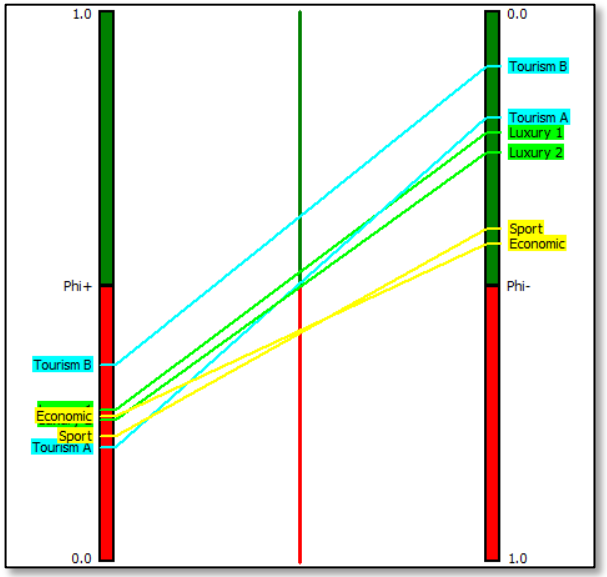


- Over 2000 papers published:
  - 80% applied – 20% theoretical
  - 57% related to "societal" fields
- Median year: 2014
- Over 3600 authors from 83 countries.

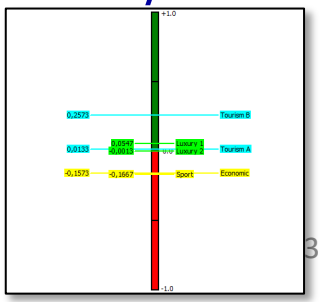
PROMETHEE I & II Rankings

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





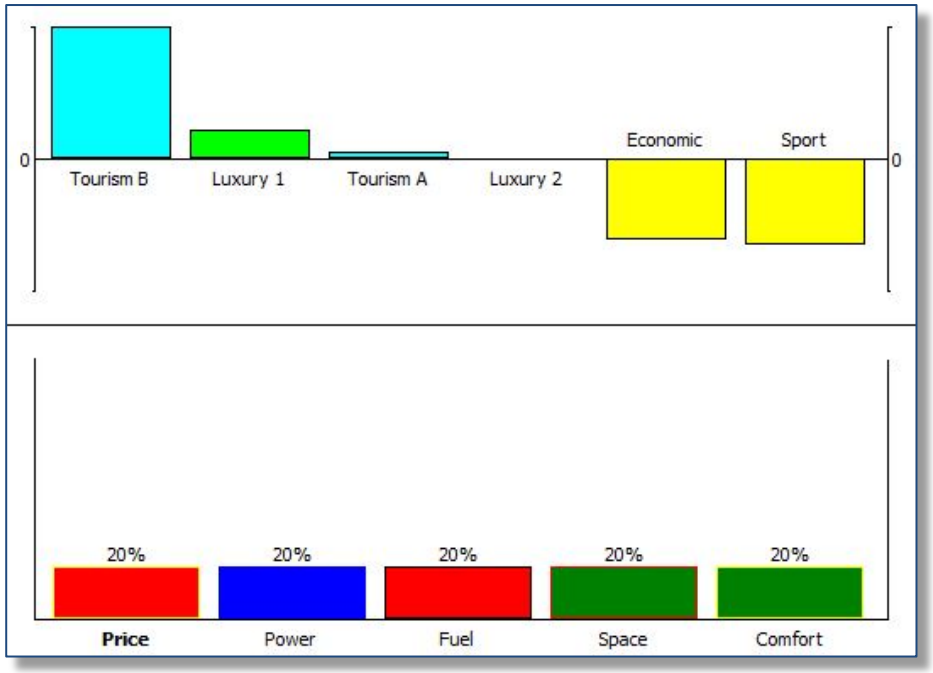
- **PROMETHEE II** : complete ranking – ϕ

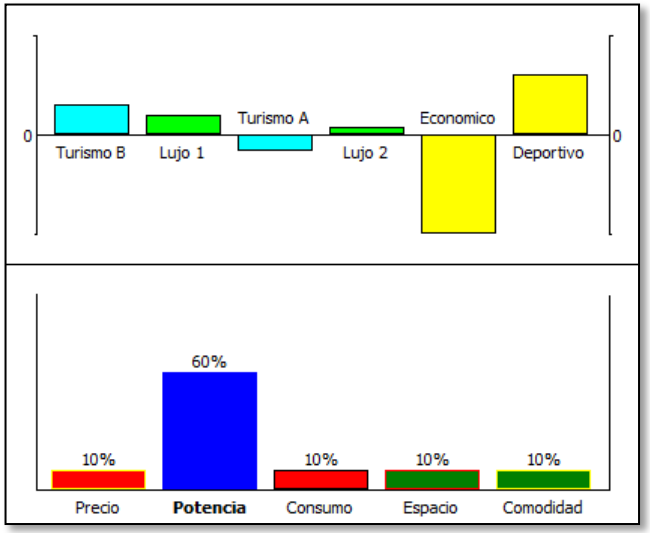


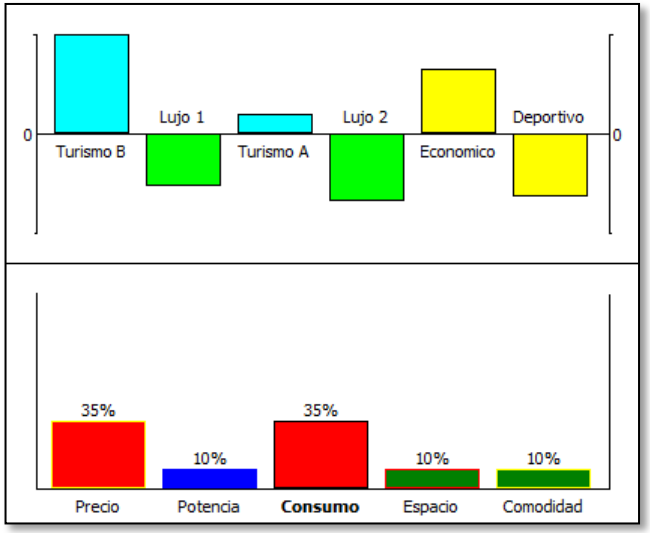
Sensitivity Analysis with **PROMETHEE**

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

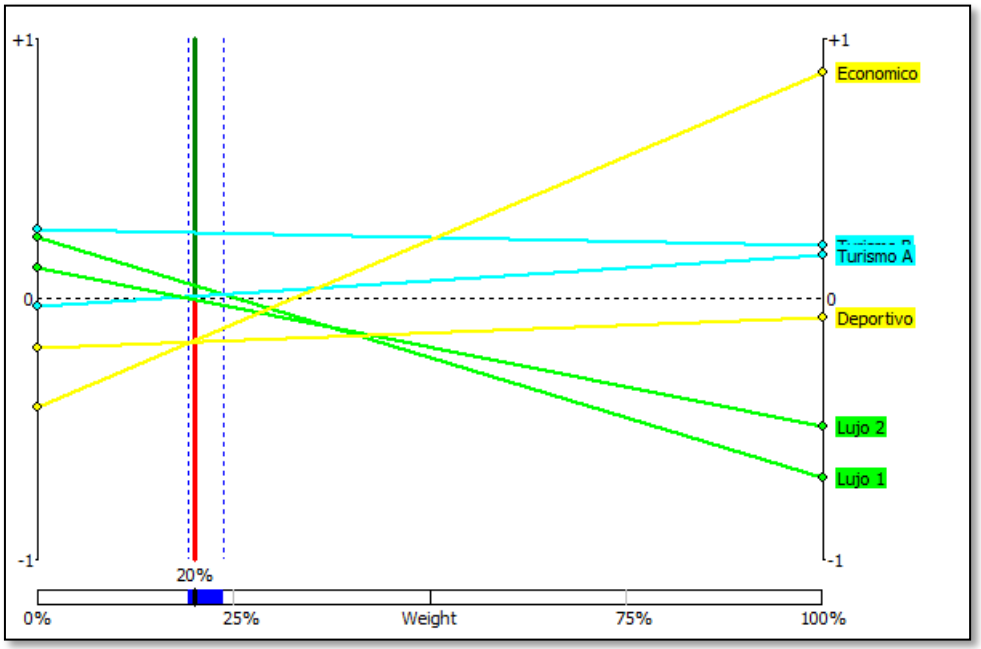
Walking Weights



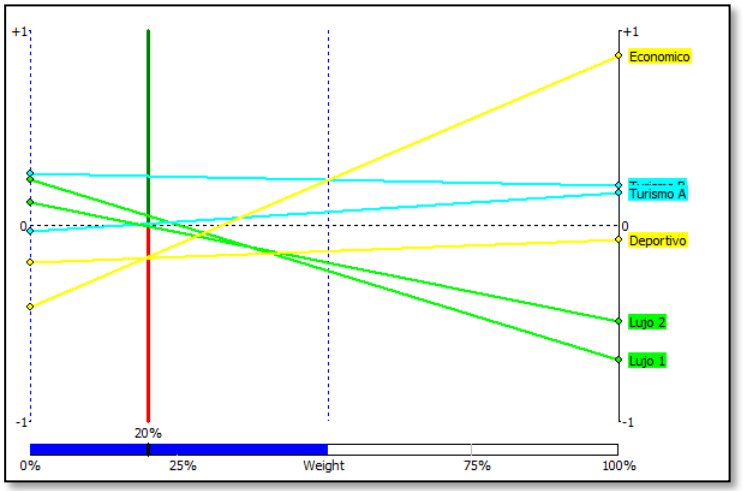




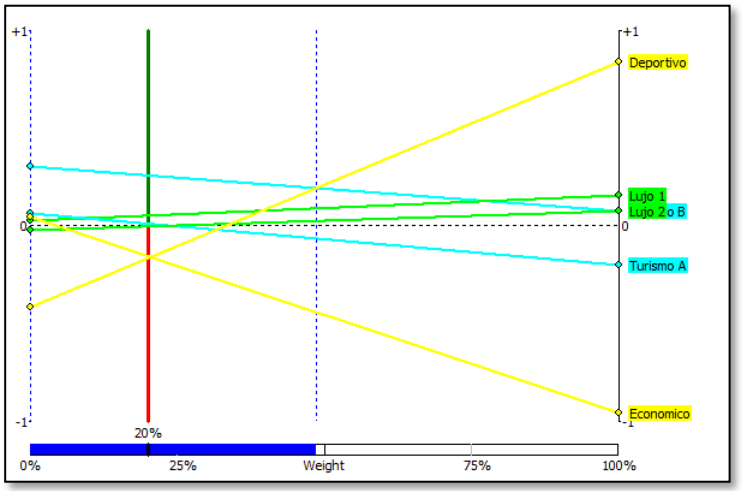
Visual Stability Intervals



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?

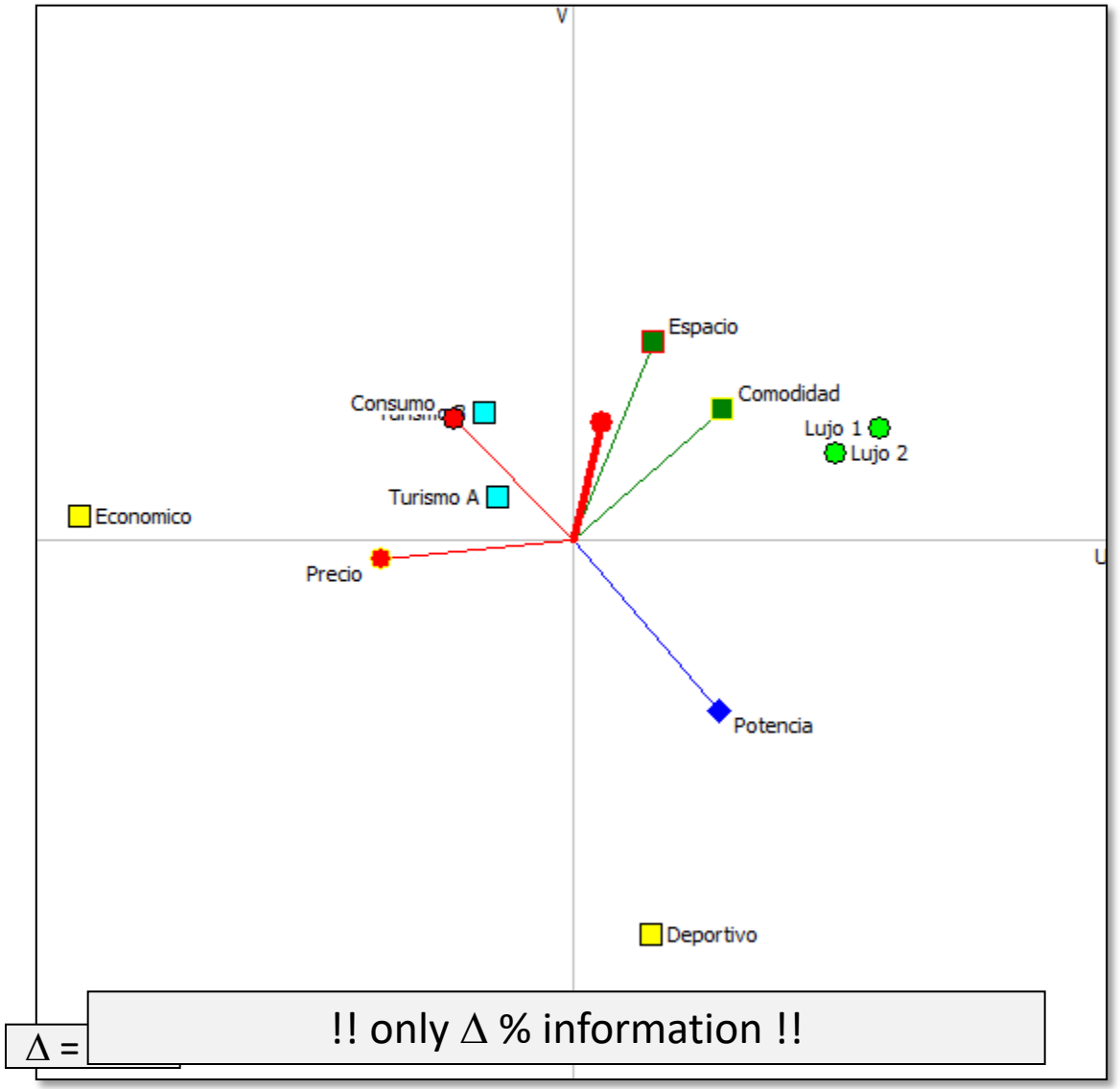
➢ Usefulness of a complementary descriptive approach.

GAIA

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

GAIA

- Actions: points
- Criteria: axes
- Decision axis



Multi-scenarios Model

- Scenarios:
  - Points of view (stakeholders – GDSS)
  - Hypotheses, …
- Evaluations:
  - ‘Objective’ criteria: common evaluations.
  - ‘Subjective’ criteria: specific evaluations for each scenario.
- Specific preference structures :
  - Weights, preference thresholds.

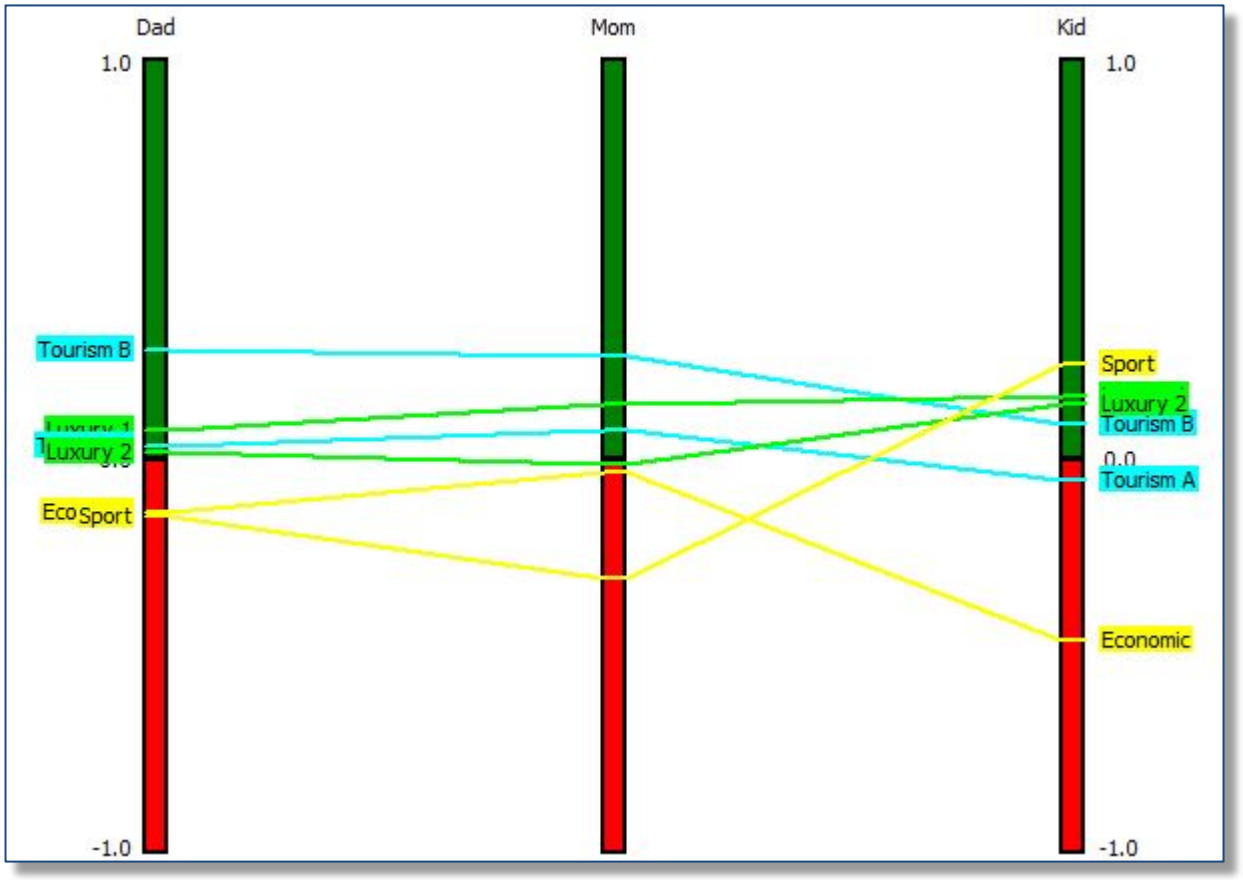
Multi-scenarios Model

- 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.

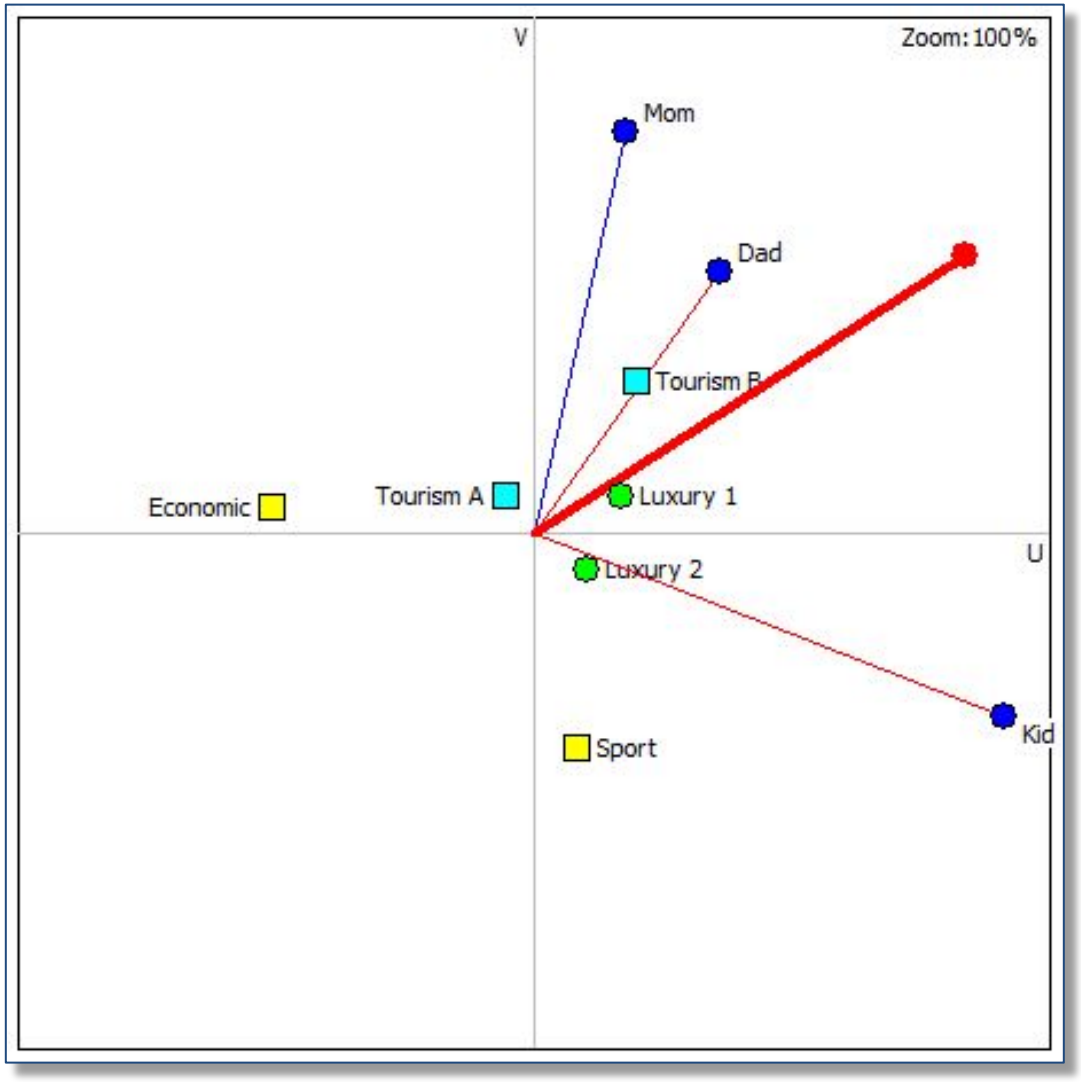
Example

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

Individual **PROMETHEE** rankings

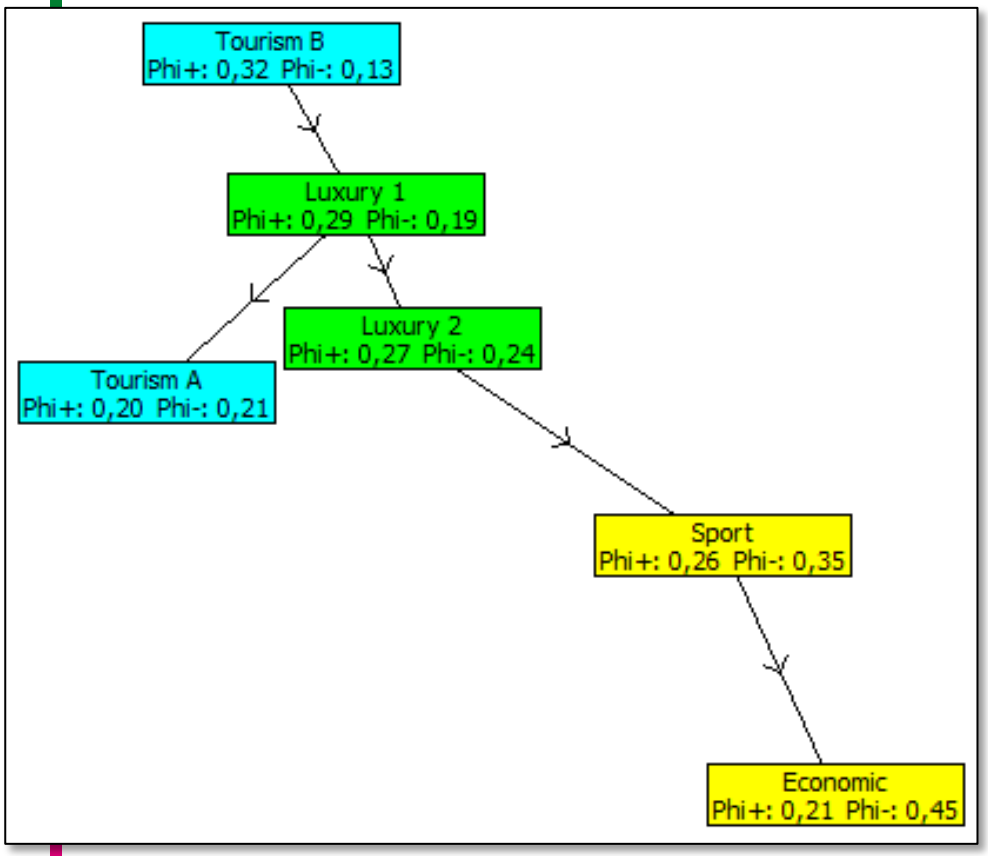


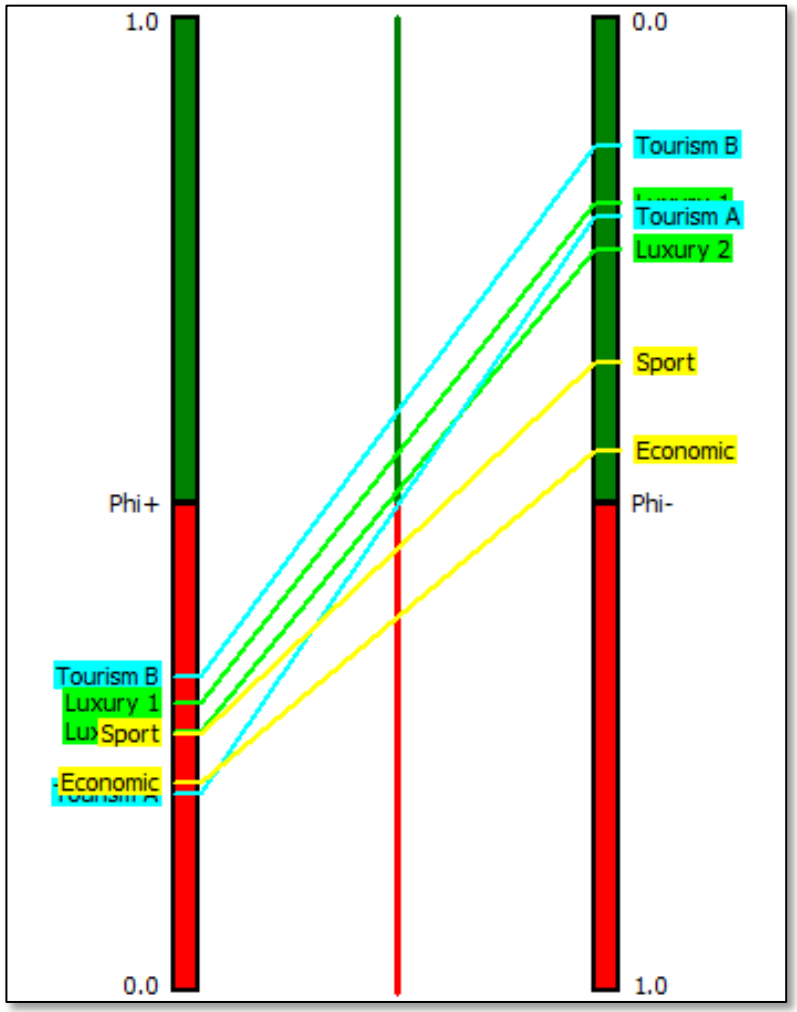
GDSS-**GAIA**: Scenarios



GDSS-**GAIA**: Criterion Comfort

« Family » (group) ranking





Visual PROMETHEE

WWW.PROMETHEE-GAIA.NET

- **Visual PROMETHEE** software:
  - **Free Academic Edition**
  - **Business Edition**
- **Visual PROMETHEE** Manual (PDF or ebook)
- More information:
  - Documents available at www.promethee-gaia.net
  - biblio.promethee-gaia.net :
    - Over 2000 references available.
  - Services: Training, Coaching, Free seminars
  - LinkedIn group, Twitter, ResearchGate, …

MCDA, **PROMETHEE** and Ethics

- **MCDA**:
  - Multiple criteria are inherent to sustainable development and ethical decision-making.
  - Weighing the criteria helps to ensure an ethical balance of the objectives.
- **PROMETHEE**:
  - Simplicity and transparency facilitate the appropriation of the method and of its results by the stakeholders.
  - Visual representations, interactive sensitivity analysis and GDSS extensions facilitate discussion and negotiation.

Conclusion

- **OR** has to shift:
  - From Unicriterion Optimization Models
  - To Multicriteria Decision Aid Models
- **OR People** should:
  - Provide decision-makers with unbiased, appropriate, meaningful and **ethical** decision aid.
  - Promote, initiate and generalize the shift towards the **multicriteria** paradigm.

What next?

- First: Thanks to all of you! 谢谢
- Continue…
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