

Visual PROMETHEE

Table of contents

Introduction	5
Welcome to Visual PROMETHEE	6
What is it about	7
What is Visual PROMETHEE	8
Demo Edition	11
Academic Edition	11
Business Edition	11
Online Edition	11
What are PROMETHEE and GAIA	11
What's new	12
Structure of the manual	12
Getting Started	14
System requirements	14
Installation	14
Size limits	14
Getting help	15
Terminology	16
Action	16
Category	16
Class	16
Cluster	16
Coalition	17
Constraint	17
Criterion	17
Decision-maker	17
Decision problem	17
Group	17
Hierarchy	18
Incomparability	18
Preference function	18
Profile	19
Qualitative scale	19
Reference set	19
Scenario	19
Weight	19
Tutorial	21
The main window	21
A guided tour	24
The PROMETHEE rankings	26
The GAIA plane	32
The Walking Weights	35
Working with multiple scenarios	37
Advanced features	45
Starting a new problem	46
How to	58
Define a new problem	58
Define the actions	59
Define the criteria	60
Define qualitative scales	61
Define the scenarios	62

Model preferences	63
Organize the criteria	64
Weigh the criteria	65
Rank different actions	65
Use the GAIA analysis	70
Perform a sensitivity analysis	71
Use weight presets	72
Generate a report	73
User Interface	74
Main Menu	74
Toolbars	77
Local Menus	79
Dialogs	80
New	80
Import data	80
Export data	81
Report Generator	82
PROMETHEE Certificate	83
Model	84
Problem Info	84
Qualitative Scales	85
Actions	85
Location	86
Criteria	87
Scenarios	88
Classes	89
Action Categories	90
Criteria Groups	91
Clusters	92
Coalitions	93
Options	94
Registration	96
Assistants	97
Problem Creation	97
Preference Function	97
Criteria Hierarchy	101
Weighing	103
Analysis	105
Windows	106
Activate	106
Group	107
Filter	108
Sort	109
PROMETHEE Rankings	110
PROMETHEE Diamond	112
PROMETHEE Network	113
PROMETHEE Rainbow	114
PROMETHEE Table	115
GAIA	116
Decision Maker Brain	117
Action Profiles	119
GAIA Webs	119
Walking Weights	121

Visual Stability Intervals	123
PROMETHEE V Selection	124
PROMETHEE Sort	126
Bank Adviser	129
Performance Analysis	130
Preference Flows	132
Scenarios Comparison	133
Balance of Power	134
PROMap	135
Weight Presets	137
Layouts	138
PROMETHEE and GAIA methods	139
MCDA	139
Multicriteria Table	141
Aggregation and Weighted Sum	142
Outranking Methods	142
PROMETHEE Preference Model	143
Seven Requisites	143
Preference Functions	144
Criteria Weights	147
Pairwise Comparisons	147
Missing values	148
PROMETHEE Rankings	149
Preference Flows	149
PROMETHEE I Partial Ranking	149
PROMETHEE II Complete Ranking	150
Rank reversal	150
GAIA	151
Unicriterion Net Flows	151
GAIA Plane	151
GAIA 3D	158
PROMETHEE VI Brain	160
Sensitivity Analysis	161
GDSS PROMETHEE	162
Multi-scenario Preference Flows	163
Consensus PROMETHEE Rankings	164
Multi-scenario GAIA	165
PROMETHEE V Selection	168
PROMETHEE Sort	170
Bank Adviser	171
Performance Analysis	172
Additional examples and exercises	174
Powerplants	174
Hypermarkets	178
Cars	183
CUV	186
Useful links	192



Visual PROMETHEE 1.4 Manual

September 5, 2013.

This is the **Visual PROMETHEE 1.4** Manual and Help file.

The content and the layout are regularly updated. Check the www.promethee-gaia.net web site for the latest version.

- [Welcome](#)
- [What is it about](#)
- [What is Visual PROMETHEE?](#)
- [What is PROMETHEE?](#)
- [What's new?](#)

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Welcome to Visual PROMETHEE

Bienvenue!
Welkom!
Willkommen!
¡Bienvenido!
Benvingut!
Bem-vindo!
Benvenuto!
Dobrodošli!
добродошли!
Witamy!
Sveiki atvykę!
Добро пожаловать!
Fáilte!
Hoşgeldiniz!
ברוך הבא!
!مرحبا
!خوش آمدید
ようこそ!
歡迎!
आपका स्वागत है!

Grata!

What is it about

Visual PROMETHEE is a multicriteria decision aid ([MCDA](#)) software.

It is designed to help you to:

- Evaluate several possible decisions or items according to multiple often conflicting criteria.
- Identify the best possible decision.
- Rank possible decisions from the best to the worst one.
- Sort items into predefined classes such as for instance: bad customers, good customers, exceptional customers.
- Visualize decision or evaluation problems to better understand the difficulties in making good decisions.
- Achieve consensus decisions when several decision-makers have conflicting points of view.
- Justify or invalidate decisions based on objective elements.

Here are some **examples** of fields of application and of how **Visual PROMETHEE** can help you:

- **Purchase of an equipment:**

Q: Which equipment is best? The cheapest? The most reliable one? The most technology advanced one? Or more probably a good compromise between price, quality and performance?

A: Define your [criteria](#) (cost, reliability, performance, look, ...). They can be quantitative (\$, kg, mph, ...) or qualitative (reliability, quality, design, ...). Model your preference (scales, thresholds, ...) and priorities ([weigh](#) the criteria). The **PROMETHEE** [rankings](#) will then show you what is (are) the best possible choice (s).

- **Procurement - Evaluation of suppliers:**

Q: Who is your best supplier for a type of product or service?

A: The best supplier should provide you with a best quality level at a most reasonable price. Price is thus one criterion that has to be confronted to quality. And quality should be evaluated on multiple criteria (quality of the products, quality of maintenance, respect of delivery terms, ...). The **PROMETHEE** [rankings](#) will show you who are the best suppliers. And the [GAIA](#) analysis can help you to negotiate better terms with your suppliers.

- **Definition of Key Performance Indicators (KPI):**

Q: How to evaluate performance of units (shops, logistic centers, teams, departments, ...) ?

A: **Visual PROMETHEE** allows for combining several indicators into a single performance score. The [Performance Analysis](#) module makes it possible to perform an Input/Output analysis and to obtain efficiency measurements.

- **Human resources management:**

Q: How to evaluate collaborators? How to select the best candidate for a job?

A: **PROMETHEE** [rankings](#) can help you identify the best candidate for a job or promotion. The [GAIA](#) analysis can be used to identify typical collaborators profiles, to identify personal weaknesses and to elaborate training programs.

- **Evaluation of projects:**

Q: How to manage a portfolio of e.g. R&D projects taking into account the expected return as well as the risk level and budget constraints?

A: The **PROMETHEE** [rankings](#) allow to evaluate different projects according to multiple criteria including return as well as risk. The [PROMETHEE V](#) selection method can then be used to elaborate a complete portfolio taking into account additional constraints such as budget limits, sectoral or geographical diversification, size, etc.

- **Investment selection:**

Q: What is the best investment solution or the best portfolio of investments taking into account return

and risk?

A: Here again the **PROMETHEE rankings** and the **PROMETHEE V** method can help you to find best balanced solutions suited to your preferences and priorities.

- **Location problems:**

Q: Where to build a new plant, a warehouse or a shop?

A: Different possible locations can be compared on many criteria such as for instance: investment cost, surface available, distance to customers, distance to suppliers, availability of transportation networks, environmental or social impacts, ... Use the **PROMETHEE rankings** to identify the best compromise solution(s).

- **Quality assessment:**

Q: How to evaluate the quality of products, of services, of procedures, of units?

A: **Visual PROMETHEE** allows you to define multiple evaluation criteria and to generate global quality scores (using the **PROMETHEE II net flow Phi**). The **GAIA** analysis and the **GAIA Webs** make it possible to make a full quality diagnosis.

- **Health care:**

Q: What is the best therapeutic choice?

A: Many health care decision problems are also multicriteria problems and can be handled by **Visual PROMETHEE**.

- **Environmental impacts and sustainable development:**

Q: How to make decisions in the context of sustainable development?

A: **Visual PROMETHEE** allows you to structure the criteria into clusters (for instance economical, environmental and social criteria) and groups (for instance air, water and soil impacts within the environmental criteria) of criteria. This makes it easier to perform **sensitivity** and what-if analyses. For instance giving more weight to the environmental criteria or less to the social ones is done very easily and the corresponding results are directly available with tools like the **Walking Weights** and the **Visual Stability Intervals**.

- **Negotiation and group decision making:**

Q: How to conciliate different and often conflicting points of view and to achieve a good consensus decision?

A: **GDSS PROMETHEE** provides extensions of the **PROMETHEE** and **GAIA** methods to the case where multiple decision makers are involved in the decision process. The multi-scenarios model enables to compare points of view, to pinpoint the sources of conflict and engage in a dynamic to solve the conflicts and to identify the best consensus decision(s).

More information about possible applications can be found at the [Decision Drive](#) web site.

Visual PROMETHEE is based on the **PROMETHEE** and **GAIA** methods that have been developed at the [ULB](#) and [VUB](#) universities of Brussels and have been widely used worldwide in many different decision or evaluation problems.

A detailed explanation of **MCDA** and the **PROMETHEE** and **GAIA** methods is available in the [last chapter](#) of this manual.

What is Visual PROMETHEE

Visual PROMETHEE is the last and most complete and up-to-date software implementation of the **PROMETHEE** and **GAIA** multicriteria decision aid (**MCDA**) methods.

Visual PROMETHEE is developed by **VPSolutions** under the supervision of Professor [Bertrand Mareschal](#) from the Solvay Brussels School of Economics and Management of the Université Libre de Bruxelles ([ULB](#)).

Professor Bertrand Mareschal has been developing and applying the **PROMETHEE** and **GAIA** methods for 30 years together with Professor Jean-Pierre Brans at the [ULB](#) and [VUB](#) universities in Brussels.

With **Visual PROMETHEE** you can share the expertise of a worldwide expert in the field of multicriteria decision aid and of one of the original authors of the **PROMETHEE** and **GAIA** methods.

PROMETHEE Software

Here is a short chronological history of **PROMETHEE**-based software.

1985 - Back in the 1980's

The first **PROMETHEE** implementation was made by Bertrand Mareschal on the ULB mainframe computer in FORTRAN around 1984. It was very different from today's software. And it was very difficult to adapt programs to different computers. The University of Split was a pioneer: they got a stack of punched cards and had the software running on their Vax system in a matter of days. Later the software was ported to the IBM PC. It was the basis for **PromCalc**.

1990 - PromCalc

The **PromCalc** software was developed around 1990 as an MS-DOS application by Bertrand Mareschal and Jean-Pierre Brans. **PromCalc** was one of the first truly interactive and graphical software available in the field of MCDA. Many universities and companies worldwide started to use it. At the end of the 1990's Windows 95 and 98 had changed the way of computing. It was time to move on.

2000 - Decision Lab

The **Decision Lab 2000** software has been developed as a joint project between ULB and the Canadian company Visual Decision. **Decision Lab** took the **PromCalc** ideas and implemented them in a MS Windows program. It was a huge step forward with respect to software usability. It is now discontinued.

2010 - D-Sight

D-Sight is a software that was developed a few years ago under the lead of Yves De Smet from ULB. The main objective was to develop **MCDA** business in a spin-off named Decision Sights. It is still available but lacks a good theoretical background.

2012 - Smart Picker Pro

This is a recent project led by Philippe Némery. Philippe got his PhD at ULB in the field of multicriteria sorting methods. His software emphasizes this aspect.

2012 - Visual PROMETHEE

The development of **Visual PROMETHEE** started in 2010 at **VPSolutions** under the supervision of Bertrand Mareschal in order to provide an adequate replacement for **Decision Lab 2000**. Most development was done from 2011 to 2012. A strong emphasis is given to the quality and consistency of the user interface, to visual aspects and to the ease of use of the software, while implementing the latest and most advanced developments of multicriteria decision aid. **Visual PROMETHEE** is the only **PROMETHEE**-based software backed by the authors of the methodology: Prof. Jean-Pierre Brans and Prof. Bertrand Mareschal.

Visual PROMETHEE is available in four different editions:

- [Demo Edition](#)
- [Academic Edition](#)
- [Business Edition](#)
- [On-line Edition](#)

Custom Editions are also available on request.

Additionally localized versions are available for the **Academic** and **Business Editions** (go to visual.promethee-gaia.net to download local versions). Currently, the following languages are available:

- English (available)
- French (available)
- Dutch (available)
- German (available - thanks to Prof. Lioba Markl-Hummel, University of Goettingen, Germany)

- Hungarian (available - thanks to Dr. Sándor Bozóki, University of Budapest, Hungary)
- Italian (available)
- Polish (available - thanks to Dr. Elżbieta Tracz, Jagiellonian University, Cracow, Poland)
- Serbian (available - thanks to Dr. Drazenko Glavic, University of Belgrade, Serbia)
- Spanish (available - thanks to Prof. Dr. Carlos Escobar Toledo, UNAM, México)

Other languages will be made available in the future. If you are interested in helping us to translate **Visual PROMETHEE** in your language send us a mail at bmaresc@ulb.ac.be. First time translators will be entitled to a life-time **Business Edition** license for free.

Demo Edition

The **Visual PROMETHEE Demo Edition** is fully functional with the following limits:

- It is not possible to save decision problems.
- Only the supplied tutorial problems can be loaded.
- [Report](#) generation, data [import/export](#) and [PROMETHEE Certificate](#) are not available.
- The analysis is limited to user-defined decision problems involving a maximum of 6 [actions](#), 6 [criteria](#) and 2 [scenarios](#).

The **Demo Edition** can be upgraded to the [Business Edition](#) through [registration](#).

Academic Edition

The **Visual PROMETHEE Academic Edition** is fully functional without any limits. It is available for free for non-profit research and teaching only. This includes but is not limited to:

- Ph.D. students thesis work.
- Non-profit research work made in academic institutions and research centers.
- Non-profit course support.

If you are not sure whether you are eligible for using the **Visual PROMETHEE Academic Edition**, please contact us at bmaresc@ulb.ac.be

As a courtesy the use of the **Visual PROMETHEE Academic Edition** software should be mentioned in all related publications.

Business Edition

The **Visual PROMETHEE Business Edition** is the complete and unrestricted edition of **Visual PROMETHEE**.

To use the **Business Edition**, you need a proper [license](#). Otherwise it reverts to the **Demo Edition**.

Online Edition

To be announced later.

What are PROMETHEE and GAIA

The [PROMETHEE](#) and [GAIA](#) methods are among the most widely used multicriteria decision aid methods.

PROMETHEE stands for **P**reference **R**anking **O**rganization **M**ETHod for the **E**nrichment of **E**valuations.

GAIA stands for **G**raphical **A**nalysis for **I**nteractive **A**id.

The **PROMETHEE I** and **II** ranking methods were first developed by Professor Jean-Pierre Brans in 1982. Two years later Jean-Pierre Brans and Bertrand Mareschal developed **PROMETHEE III** (ranking based on intervals) and **PROMETHEE IV** (continuous decision problems). These two variants are not implemented. In 1988 **GAIA** was introduced which is a graphical complement to the **PROMETHEE** rankings. In 1992 **PROMETHEE V** was proposed as a solution for multiple selection under constraints. And in 1994 **PROMETHEE VI** (the "Decision-Maker Brain") was implemented in the **PromCalc** software.

In 30 years, several hundreds of scientific papers related to **PROMETHEE** and **GAIA** have been published in scientific journals all around the world. You can check the on-line Bibliographical Database at <http://biblio.promethee-gaia.net>. As of August 2013 more than 460 references were available.

Many organizations (private companies, public administrations, research centers, universities, individuals, ...) worldwide have been using **PROMETHEE**-based software for their decision-making or evaluation problems in various fields such as: banking, location of facilities, human resources management, water resources, investment, medicine and health care, chemistry, procurement, environmental problems, planning, project management, ...

If you want to discuss the potential of **Visual PROMETHEE** for your own decision or evaluation problems, please contact Bertrand Mareschal at bmaresc@ulb.ac.be.

What's new

Currently (August 12, 2013), the **Visual PROMETHEE 1.4 Demo**, **Academic** and **Business Editions** are available in eight different languages.

Additional localized versions are expected later in 2013.

There is a new tutorial available that shows you [how to define and analyze](#) a decision problem step by step from the beginning.

Version 1.2 introduced two main new features:

- [Network display](#) of the **PROMETHEE I** Partial Ranking (improved with respect to **Decision Lab** and **PromCalc**).
- Decision stick display in the [GAIA plane](#).

Version 1.3 introduced additional features:

- MS Excel interface for [import/export](#) of data.
- PDF and XLS(X) [reports](#).
- Improved [localization](#).

Version 1.4 now introduces:

- A completely rebuilt and much improved [Weighing Assistant](#).
- A redesigned [PROMETHEE Table](#) window.

Structure of the manual

This **Visual PROMETHEE** Manual is organized in several sections as follows:

- [Introduction](#)
This is the place where you are now. ;-)
- [Getting started](#)
This section includes general information about installing and using **Visual PROMETHEE**.
- [Terminology](#)
A comprehensive [list of terms](#) used in the software.
- [Tutorial](#)
The tutorial provides the user with the basic elements to use **Visual PROMETHEE**. It includes an overview of the [user interface](#) and of the most important [analyses](#) available. There is also a complete walk-through for [starting and analyzing a new problem](#).
- [How to](#)
This section contains more detailed "how to" information about specific situations:
 - [Define a new problem](#)
 - [Rank different actions](#)
 - [Use the GAIA analysis](#)

- [Perform a sensitivity analysis](#)
 - [Use weight presets](#)
 - [Generate a report](#)
- **[User interface](#)**
This section describes the main elements of the user interface: the [main menu](#), the [toolbars](#) and the [local menus](#).
- **[Dialogs](#)**
This is a detailed description of all the dialogs in **Visual PROMETHEE**. Use it to find information specific to a dialog.
- **[Assistants](#)**
The five assistants available in **Visual PROMETHEE**:
 - [Problem Creation](#)
 - [Preference Function](#)
 - [Criteria Hierarchy](#)
 - [Weighing](#)
 - [Analysis](#)
- **[Windows](#)**
This is a detailed description of all the windows in **Visual PROMETHEE**. Use it to find information specific to a window.
- **[PROMETHEE and GAIA methods](#)**
This section is devoted to a deeper methodological (and thus more mathematical) description of the **PROMETHEE** and **GAIA** methods:
 - [MCDA](#): What is multicriteria decision aid?
 - [PROMETHEE Preference Model](#): [Preference functions](#) and [weights](#) explained.
 - [PROMETHEE Rankings](#): How the **PROMETHEE** rankings are computed.
 - [GAIA](#): How the **GAIA** plane is computed and what information it does contain.
 - [Sensitivity Analysis](#): Why and how to perform a sensitivity analysis.
 - [GDSS PROMETHEE](#): How the **PROMETHEE** and **GAIA** methods are extended to the **GDSS** dimension.
 - [PROMETHEE V Selection](#): How to make multiple selection under constraints.
 - [PROMETHEE Sort](#): How to sort actions in predefined [classes](#).
 - [Bank Adviser](#): How to use **PROMETHEE** to perform [reference](#)-based evaluation.
 - [Performance Analysis](#): How to measure performance by comparing input and output criteria.
- **[Additional examples and exercises](#)**
Four additional example datasets are introduced and analyzed. Exercises are provided for a better practice with **Visual PROMETHEE**.
- **[Useful links](#)**
Links to useful websites and sources of information.

Getting Started

Thank you for using **Visual PROMETHEE**.

Here are some information about the software and its use.

- [System requirements](#)
- [Getting help](#)

System requirements

Visual PROMETHEE is a MS-Windows program. It runs on Windows XP, Vista, 7, 8 and later.

It is possible to run **Visual PROMETHEE** on Linux or MacOS systems using a virtual machine (e.g. WINE for Linux systems). All functionalities are not necessarily available in this case. Native MacOS and iOS versions of **Visual PROMETHEE** are considered as a possible future development.

The **GIS PROMap** feature requires an Internet connection.

There are no other special requirements.

Installation

Visual PROMETHEE is available for download either as a Windows installation file (**VPsetup.msi**) or an archive file (**PROMETHEE.zip**).

We recommend downloading the Windows installation file as it makes the full installation process much easier. Also some features such as file association are not available when installing from the archive. The archive should thus only be used when the Windows installation file cannot be used (for instance on a Linux computer).

Installing from the Windows installation file

Double-click the **VPsetup.msi** file to launch the installation and then follow the instructions. During the installation process you will have to read and agree with the **Visual PROMETHEE** license.

Installing from the archive

Double-click the **PROMETHEE.zip** file to open the archive.

1. Unzip the contents of the archive into a folder.
2. Create the following folders:
 - C:\Users\<youname>\AppData\Local\VPsolutions
 - C:\Users\<youname>\AppData\Local\VPsolutions\Images
3. Copy the PROMETHEE.ini, VPimage.gif and VPimage.jpg files into the VP solutions folder.

Size limits

Visual PROMETHEE has the following limits (**Business** and **Academic Editions**) relative to the dimensions of the decision problems it can handle:

- Maximum number of [actions](#): 10000
 - Maximum number of [categories](#): 50
- Maximum number of criteria: 10000
 - Maximum number of [groups](#): 50
 - Maximum number of [clusters](#): 50
- Maximum number of [scenarios](#): 10
 - Maximum number of [coalitions](#): 10
- Maximum number of evaluations: 100000

(the number of evaluations is the product of the number of actions by the number of criteria by the number of scenarios)

- Maximum number of [PROMETHEE Sort classes](#): 10
- Maximum number of [PROMETHEE V constraints](#): 50

Larger dimensions are available to **Custom Editions**. Please contact bmaresc@ulb.ac.be for inquiries.

Getting help

Help related to **Visual PROMETHEE** or to the use of the **PROMETHEE** and **GAIA** methods can be found:

- In this help file/manual. The manual is also available in PDF, ePub and Mobi formats.
- In the **PROMETHEE-GAIA FAQ** at <http://faq.promethee-gaia.net>
- On the **PROMETHEE-GAIA Forum** at <http://forum.promethee-gaia.net>

Additional information can also be found:

- On the **PROMETHEE-GAIA Blog** at <http://blog.promethee-gaia.net>
- On the **LinkedIn PROMETHEE Decision Aid Methods group**

And you can follow us on **Twitter** at [@bmaresc](https://twitter.com/bmaresc)

Terminology

This is an alphabetical list of the main terms used in this document. Click a term to access its definition.

- [Action](#)
- [Category](#)
- [Class](#)
- [Cluster](#)
- [Coalition](#)
- [Constraint](#)
- [Criterion](#)
- [Decision-maker](#)
- [Decision problem](#)
- [Group](#)
- [Hierarchy](#)
- [Incomparability](#)
- [Preference function](#)
- [Profile](#)
- [Qualitative scale](#)
- [Reference set](#)
- [Scenario](#)
- [Weight](#)

Action

The term **action** is used to designate either a possible decision or an item to evaluate. **Visual PROMETHEE** compares different actions that are evaluated on several criteria.

Synonyms are: alternative, decision, item.

Actions can be created or modified from the [Actions](#) dialog. Click "**Model | Actions...**" to open the dialog.

Category

An action **category** defines a subset of actions that share the same symbol and colors in the analysis.

Categories can be created or modified from the [Action Categories](#) dialog. Click "**Model | Action Categories...**" to open the dialog.

Class

Classes represent types of actions ([profiles](#)) in the context of [sorting](#). The objective is to assign each [action](#) to one class.

In **Visual PROMETHEE** classes can be:

- ordered from the best to the worst (for instance good customers, average customers and bad customers in a context of credit allocation),
- unordered (for instance different consumer profiles such as e.g. switchers, variety seekers, deal-prone, trend-setters, ...).

Classes can be created or modified from the [Classes](#) dialog. Click "**Model | Classes...**" to open the dialog.

Cluster

A **cluster** defines a subset of criteria within one or several [criteria groups](#). It is a the top level of the **Visual PROMETHEE** [hierarchy](#) of [criteria](#).

A cluster can also be "grouped" to simplify the analysis and to facilitate sensitivity analyses: "grouped" clusters appear as a single item in all **Visual PROMETHEE** analyses.

Clusters can be created or modified from the [Clusters](#) dialog. Click "**Model | Clusters...**" to open the dialog.

Coalition

A coalition is a group of [decision-makers](#). [Scenarios](#) in the same coalition share a same color, fill color and shape for easier identification in the **PROMETHEE** and **GAIA** analyses.

Coalitions can be created or modified from the [Coalitions](#) dialog. Click "**Model | Coalitions...**" to open the dialog.

Constraint

Constraints are used in the [PROMETHEE V](#) multiple selection procedure.

They are linear equations or inequalities that the **PROMETHEE V** selection must fulfill according to the requirements of the decision-maker.

Criterion

A **criterion** is an attribute associated to each action that makes it possible to compare the [actions](#) and to determine the best ones.

It can be quantitative (a number is associated to each action, such as the price of an item) or qualitative (in this case, a qualitative scale must be defined with a number of ordered levels such as for instance: very bad, bad, average, good, very good).

Criteria can be created or modified from the [Criteria](#) dialog. Click "**Model | Criteria...**" to open the dialog.

Decision-maker

In the context of **Visual PROMETHEE** a **decision-maker** is a person or an organization that is responsible for a decision or implied in the decision process.

For a given decision problem there can be either a single or multiple decision-makers.

In **Visual PROMETHEE** each decision-maker has to be associated to one [scenario](#) and thus can express his/her preferences and priorities independently from the other decision-makers.

Synonyms are **actor** or **stakeholder**.

Decision problem

In **Visual PROMETHEE** a **decision problem** is defined by:

- A set of [actions](#): These are the possible decisions or choices, or are items to evaluate.
- A set of [criteria](#): These are the attributes that are used to compare the actions. They represent the objectives of the [decision-maker](#).
- One or several [scenarios](#): Each scenario contains specific evaluations and preference information. Scenarios can represent the points of view of different [decision-makers](#) or different hypotheses.

General information related to the decision problem can be edited in the [Problem Info](#) dialog.

Group

A **criteria group** defines a subset of [criteria](#) that share the same outline color within a cluster in the analysis. A criteria group can also be "grouped" to simplify the analysis and to facilitate sensitivity

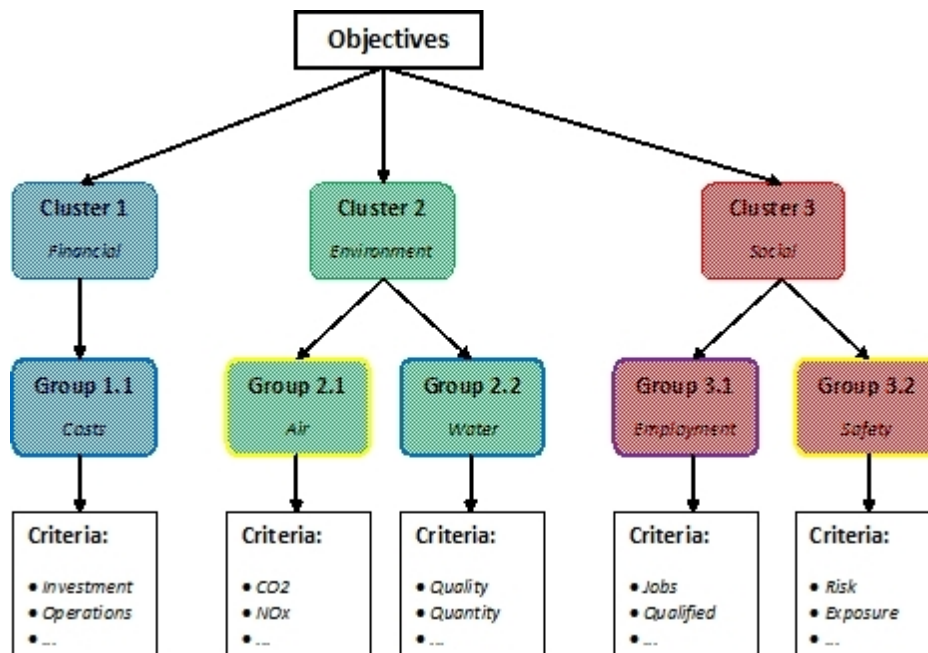
analyses: "grouped" criteria groups appear as a single item in all **Visual PROMETHEE** analyses.

Each criteria group belongs to a cluster. It is the intermediate level of the **Visual PROMETHEE** criteria [hierarchy](#).

Criteria groups can be created or modified from the [Criteria Groups](#) dialog. Click "**Model | Criteria Groups...**" to open the dialog.

Hierarchy

The criteria **hierarchy** in **Visual PROMETHEE** has three levels:



- At the top level are the [clusters](#). They are identified by a shape and a fill color.
- At the intermediate level are the [criteria groups](#). Each criteria group belongs to a cluster. They are identified by their cluster shape and fill color and by a specific outline color.
- At the bottom level are the individual criteria. Each [criterion](#) belongs to a criteria group.

The [Hierarchy Assistant](#) can help you to define the criteria hierarchy.

Incomparability

Incomparability arises when the comparison of two [actions](#) is difficult, usually because they have quite different profiles and one is better than the other on several [criteria](#) while the other is better on other criteria.

It doesn't mean that the two actions cannot be compared. It means that the comparison is difficult. The introduction of incomparabilities in the [PROMETHEE I Partial Ranking](#) makes it easier for the decision-maker to detect difficult choices.

Preference function

A preference function has to be associated to each [criterion](#) in **Visual PROMETHEE**.

The preference function defines how pairwise evaluation differences are translated into degrees of preference. It reflects the perception of the criterion scale by the [decision-maker](#).

Six different [shapes](#) of preference functions are available in **Visual PROMETHEE** to accommodate most practical situations.

The [Preference Function Assistant](#) is available for helping to choose the right preference function.

Profile

A profile is an [action](#) that is used to define a [class](#). It can be either an actual action or a fictive one.

There are two types of profiles that can be used in [PROMETHEE Sort](#):

- boundary: in that case, the profile is representative of the upper bound of the class,
- central: in that case, the profile is representative of an action belonging to the class.

In **Visual PROMETHEE** profiles appear as regular actions in the spreadsheet. They should be associated to the [action category](#) of the corresponding [class](#).

Qualitative scale

Qualitative [criteria](#) are evaluated on a **qualitative scale** rather than with numbers.

In **Visual PROMETHEE** a qualitative scale is defined by:

- a number of ordered levels (from worst to best),
- numerical values associated to these levels,
- whether the numerical values should be minimized or maximized (scale orientation).

Different qualitative scales can be defined with **Visual PROMETHEE** using the [Qualitative Scales](#) dialog.

Reference set

The notion of reference set is used in [Bank Adviser](#): it is a set of reference [actions](#) to which each action is compared.

The reference set can be for instance:

- a set of well-known actions,
- a subset of actions (for instance geographically defined),
- a set of reference points (fictive actions),
- a peer-group.

In **Visual PROMETHEE** the reference set has to be a [category](#) of actions.

Scenario

A **scenario** is a set of evaluations and preference parameters that is defined for a decision problem.

Scenarios can represent:

- the point of view of different [decision-makers](#),
- different hypotheses.

Scenarios can be created or modified from the [Scenarios](#) dialog. Click "**Model | Scenarios...**" to open the dialog.

Weight

The **weight** of a [criterion](#) is a positive number that represents the criterion relative importance.

The [Weighing Assistant](#) can be used to assess the weights of the criteria.


Weights can also be allocated to the [scenarios](#) for instance to represent different decision making levels in a group decision problem.

The [Balance of Power](#) window can be used to assess the weights of the scenarios.

In **Visual PROMETHEE** weights are always automatically normalized so that their sum is equal to 1 (100%)
. The user can enter any positive number as a weight.

Tutorial

After you have installed **Visual PROMETHEE** on your computer, a **Visual PROMETHEE** icon will appear on the desktop.

Double-click the  icon to start **Visual PROMETHEE**.

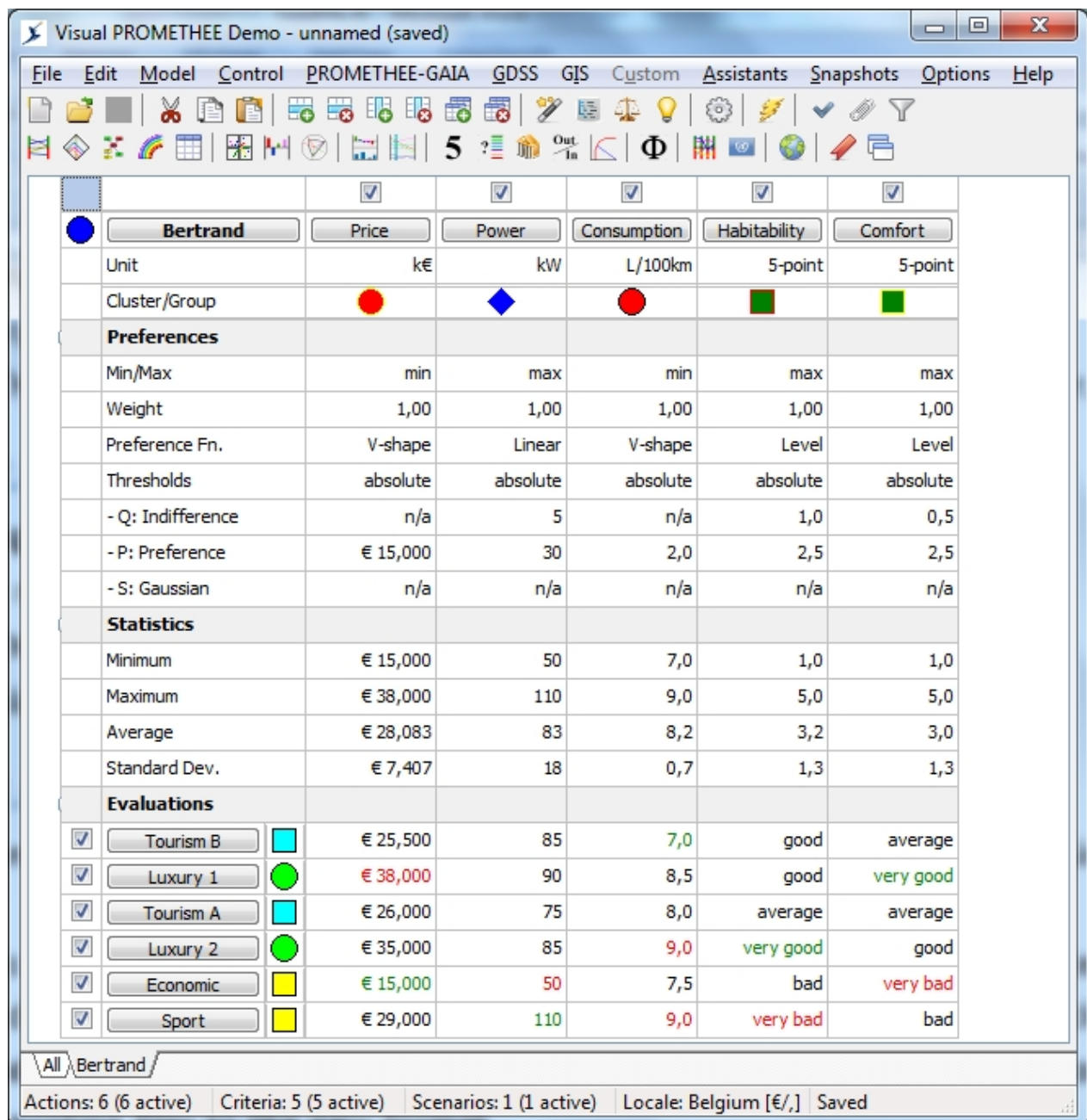
The tutorial is organized in five sections in the following order:

- [The main window](#)
- [A guided tour](#)
- [Working with multiple scenarios](#)
- [Advanced features](#)
- [Starting a new problem](#)

Several additional tutorial examples including exercises are available in the [last section](#) of this manual.

The main window

When you start **Visual PROMETHEE** the main window is displayed.



The main window is organized as follows, from top to bottom:

- The [Main Menu](#) is displayed on the top of the window.
- There are two [Toolbars](#) with important commands:
 - Data management on the upper row.
 - Analysis management on the lower row.
- The main part of the window is the spreadsheet:
 - Most data are displayed and can be edited from the spreadsheet.
 - On the top section are the current scenario name ("Bertrand" in the above screen shot) and the criteria names together with check boxes for activating/deactivating the criteria and unit and cluster/group information. Click on the buttons to access [scenario](#) or [criterion](#) dialogs.
 - The spreadsheet contains three collapsible sections: Preferences, Statistics and Evaluations. Click on the small icons in the leftmost column to collapse/expand these sections.
 - Preferences: For each criterion, the following data are available:
 - Min/max: select whether the criterion has to be minimized or maximized.
 - Weight: enter the weight of the criterion (weights are automatically normalized)

by the software).

- Preference Fn.: select the preference function type (or select "Help me" to use the [Preference Function Assistant](#)).
- Thresholds: select either "absolute" (thresholds expressed on the criterion scale of measurement) or "percentage" (thresholds expressed as percentages).
- Q: Indifference: Indifference threshold.
- P: Preference: Preference threshold.
- S: Gaussian: Gaussian threshold.
- Statistics: For each criterion, the following statistics are computed from the active actions: minimum and maximum values, arithmetic average and standard deviation.
- Evaluations: There is one row for each action. The check box is used to control the activation/deactivation of the action. Click on the name button to open the [action](#) dialog. The shape identifies the action's category. Evaluations can be entered in different ways:
 - For quantitative criteria, enter the numerical value.
 - For qualitative scales, a drop-down list allows to choose the evaluation.
 - [Missing values](#) are allowed: enter "?" for a missing value. "n/a" (not available) stands for missing values.
- At the bottom of the spreadsheet are tabs:
 - For each scenario, there is a tab. Click on the tab to switch to that scenario.
 - The "All" tab switches to the multi-scenarios analysis.
- The bottom of the main window displays a status bar with some general information related to the current problem (dimensions, locale and save status). The status bar is clickable.

A guided tour

When starting **Visual PROMETHEE** a demo dataset is automatically loaded.

	Price	Power	Consumption	Habitability	Comfort
Unit	k€	kW	L/100km	5-point	5-point
Cluster/Group					
Preferences					
Min/Max	min	max	min	max	max
Weight	1,00	1,00	1,00	1,00	1,00
Preference Fn.	V-shape	Linear	V-shape	Level	Level
Thresholds	absolute	absolute	absolute	absolute	absolute
- Q: Indifference	n/a	5	n/a	1,0	0,5
- P: Preference	€ 15,000	30	2,0	2,5	2,5
- S: Gaussian	n/a	n/a	n/a	n/a	n/a
Statistics					
Minimum	€ 15,000	50	7,0	1,0	1,0
Maximum	€ 38,000	110	9,0	5,0	5,0
Average	€ 28,083	83	8,2	3,2	3,0
Standard Dev.	€ 7,407	18	0,7	1,3	1,3
Evaluations					
<input checked="" type="checkbox"/> Tourism B	€ 25,500	85	7,0	good	average
<input checked="" type="checkbox"/> Luxury 1	€ 38,000	90	8,5	good	very good
<input checked="" type="checkbox"/> Tourism A	€ 26,000	75	8,0	average	average
<input checked="" type="checkbox"/> Luxury 2	€ 35,000	85	9,0	very good	good
<input checked="" type="checkbox"/> Economic	€ 15,000	50	7,5	bad	very bad
<input checked="" type="checkbox"/> Sport	€ 29,000	110	9,0	very bad	bad

All Bertrand

Actions: 6 (6 active) Criteria: 5 (5 active) Scenarios: 1 (1 active) Locale: Belgium [€/€] Saved

The demo dataset is about the purchase of a new car. This problem has been used as an example in many **PROMETHEE** presentations (check the resources section at <http://www.promethee-gaia.net> to download presentations) and it was also provided as a tutorial with the **Decision Lab** software. So previous users should be familiar with it.

Let us suppose that somebody (the [decision-maker](#)) wants to purchase a new car and hesitates between six possible models (the [actions](#)):

- Two cars that we name **Tourism A** and **Tourism B**. These are classical family sedans.
- A more economical car that we name **Economic**.
- Two more luxury cars: **Luxury 1** and **Luxury 2**.

- And a more powerful car that we call **Sport**.

The names are chosen on purpose to reflect the characteristics of each car and to make it easier to understand how **PROMETHEE** and **GAIA** can help the decision-maker. In actual decision problems, the characteristics of the actions are usually much less obvious at first sight and **PROMETHEE** and **GAIA** will help you to discover these.

We suppose that the decision-maker has identified five [criteria](#) as important for choosing his/her new car:

- **Price**: That is the price of the car, expressed in Euros (€). Obviously the decision-maker prefers a lower price so this criterion should be minimized.
- **Power**: That is the power of the car, expressed in kW. This criterion should be maximized as more power is preferable.
- **Consumption**: Gas efficiency is measured the European way: it is the number of liters of gas consumed per hundred kilometers. It has thus to be minimized.
- **Habitability**: The perception of space is subjective and this criterion calls for a qualitative scale. Here we use the classical 5-point scale: very bad, bad, average, good and very good.
- **Comfort**: The comfort of each car is evaluated on the same 5-point scale (very bad to very good).

As you see Visual PROMETHEE can handle quantitative as well as [qualitative](#) criteria.

There is a column for each criterion and a row for each action (at the bottom of the spreadsheet).

The **Preferences** section contains information about the preferences of the decision-maker:

- **Min/max**: indicates whether the criterion should be minimized or maximized.
- **Weight**: the weight of a criterion is a measure of how much it is important with respect to the other criteria. In the demo all the weights are equal so that the five criteria are considered to be equally important. The weights can be adjusted according to the priorities of the [decision-maker](#), to the position of the [GAIA](#) decision axis or to the results of a [sensitivity analysis](#).
- **Preference Fn.**: Here you can see what type of [preference function](#) has been associated to each criterion.
- **Thresholds**: Absolute thresholds have been selected for all the criteria. The corresponding thresholds are thus expressed on each criterion's scale.
 - Q: Indifference threshold.
 - P: Preference threshold.
 - S: Gaussian threshold.

The **Statistics** section displays some basic statistics for the criteria:

- **Minimum**: for instance the cheapest car has a price of 15,000 €.
- **Maximum**: the most expensive car has a price of 38,000 €.
- **Average**: the average price (over all active actions) is equal to 28,083 €.
- **Standard Dev.**: the standard deviation of the prices of the active actions is equal to 7,407 €.

For each criterion, the best value is displayed in green and the worst one in red: for instance the **Economic** car is the cheapest one while the **Luxury 1** is the most expensive.

Actions, criteria and scenarios (in this dataset there is only one [scenario](#) named **Bertrand**) names are actually buttons that you can click to open the corresponding [Actions](#), [Criteria](#) and [Scenarios](#) dialogs in order to display and edit specific data.

The check boxes on the top row and in the leftmost column of the spreadsheet allow to control which criteria and/or actions are active. If you un-check one box, the corresponding criterion or action will be removed from the analysis. It is thus very easy to make what-if analysis and to see the impact of one action or criterion on the results of the analysis.

The colored symbols (circles, squares or diamonds) associated to the actions and the criteria correspond to the defined action [categories](#) and to the criteria [hierarchy](#).

Let us now start the analysis of the data.

- [Have a look at the PROMETHEE rankings.](#)
- [Learn to use the GAIA plane.](#)
- [Make a sensitivity analysis.](#)

The PROMETHEE rankings

There are two **PROMETHEE** rankings that are computed:

- The **PROMETHEE I** Partial Ranking is based on the computation of two [preference flows](#) (Φ^+ and Φ^-). It allows for incomparability between actions when both Φ^+ and Φ^- preference flows give conflicting rankings.
- The **PROMETHEE II** Complete Ranking is based on the net [preference flow](#) (Φ).

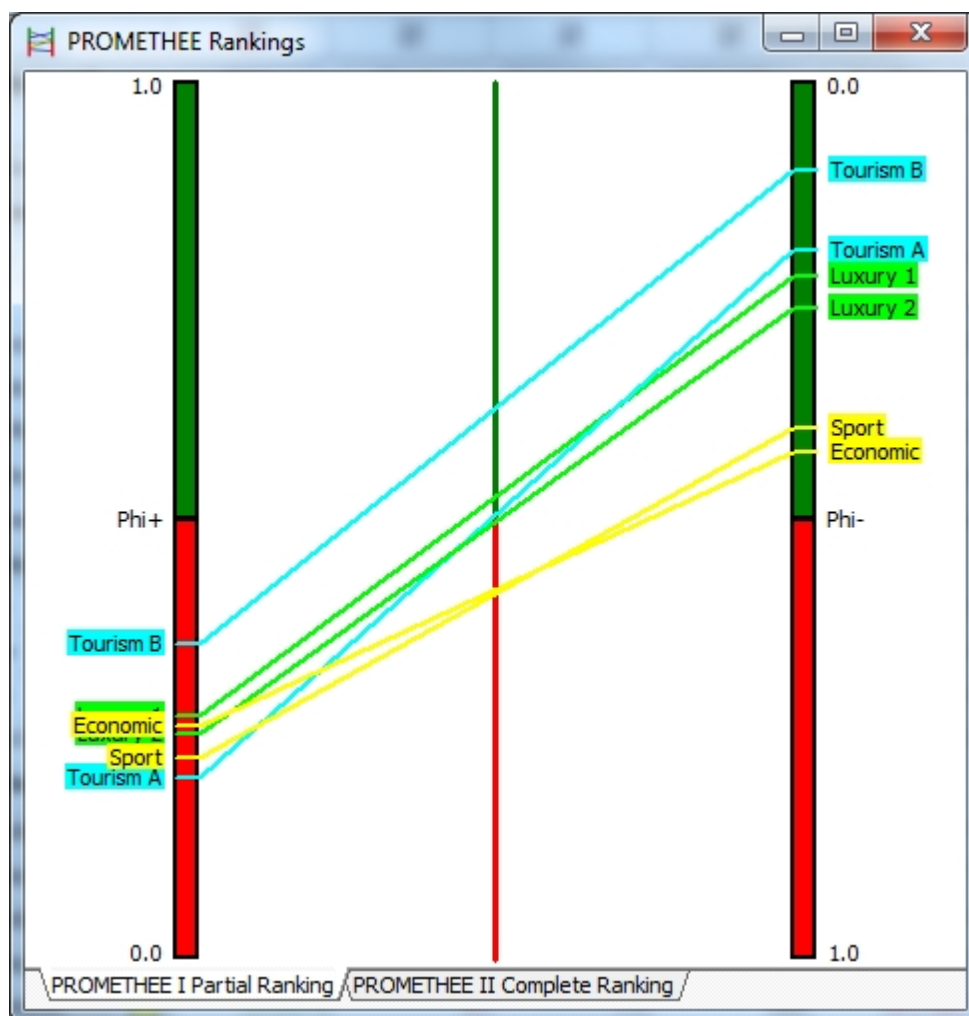
Visual PROMETHEE offers several ways to display the **PROMETHEE** rankings.

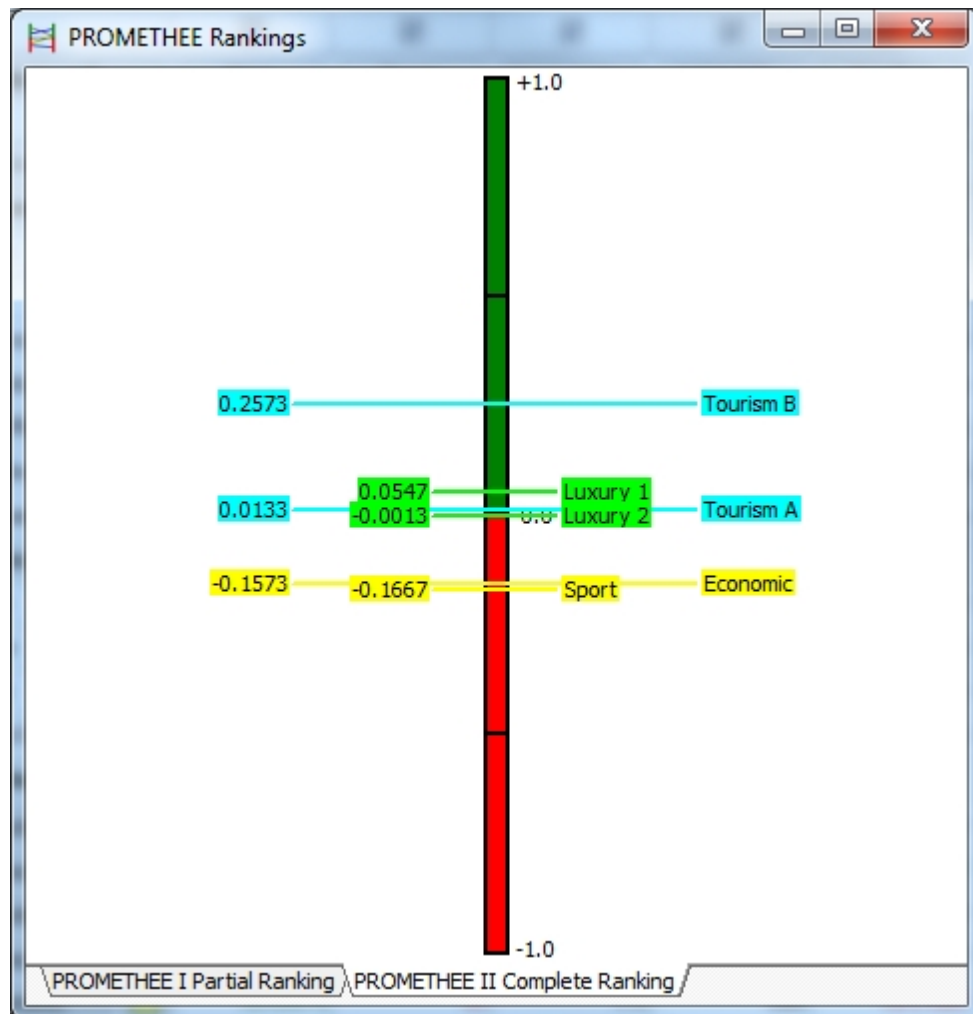
PROMETHEE Rankings

Click "**PROMETHEE-GAIA | PROMETHEE Rankings**" to open this window.

The [PROMETHEE Rankings](#) window has two tabs that can be selected at the bottom of the window:

- **PROMETHEE I** Partial Ranking
- **PROMETHEE II** Complete Ranking





On the **PROMETHEE I** Partial Ranking tab (left figure), the leftmost bar shows the ranking of the actions according to Φ^+ : **Tourism B** is on top, followed by **Luxury 1**, **Economic**, **Luxury 2**, **Sport** and **Tourism A**. The rightmost bar shows the ranking according to Φ^- : **Tourism B** is still on top, but it is followed by **Tourism A**, **Luxury 1**, **Luxury 2**, **Sport** and **Economic**.

We can conclude that:

- **Tourism B** is preferred to all the other actions in the **PROMETHEE I** ranking.
- **Luxury 1** is on top of **Luxury 2** but they are very close to each other.
- **Tourism A** is incomparable with the **Luxury** cars because it has a worse score on Φ^+ and a better one on Φ^- .
- **Sport** and **Economic** are also incomparable with each other but they are lagging with respect to the other ones. Indeed even if their Φ^+ score are similar to the previous cars, their Φ^- scores are well behind.

This is confirmed by the **PROMETHEE II** complete ranking (right figure). Three groups of actions appear clearly:

- **Tourism B** has a higher Φ score.
- **Luxury 1**, **Tourism A** and **Luxury 2** have lower scores and are all very close to zero. They are more average actions.
- **Economic** and **Sport** have also very close but negative scores. They are at the bottom of the **PROMETHEE II** ranking.

While the **PROMETHEE II** complete ranking is easier to explain it is also less informative as the differences

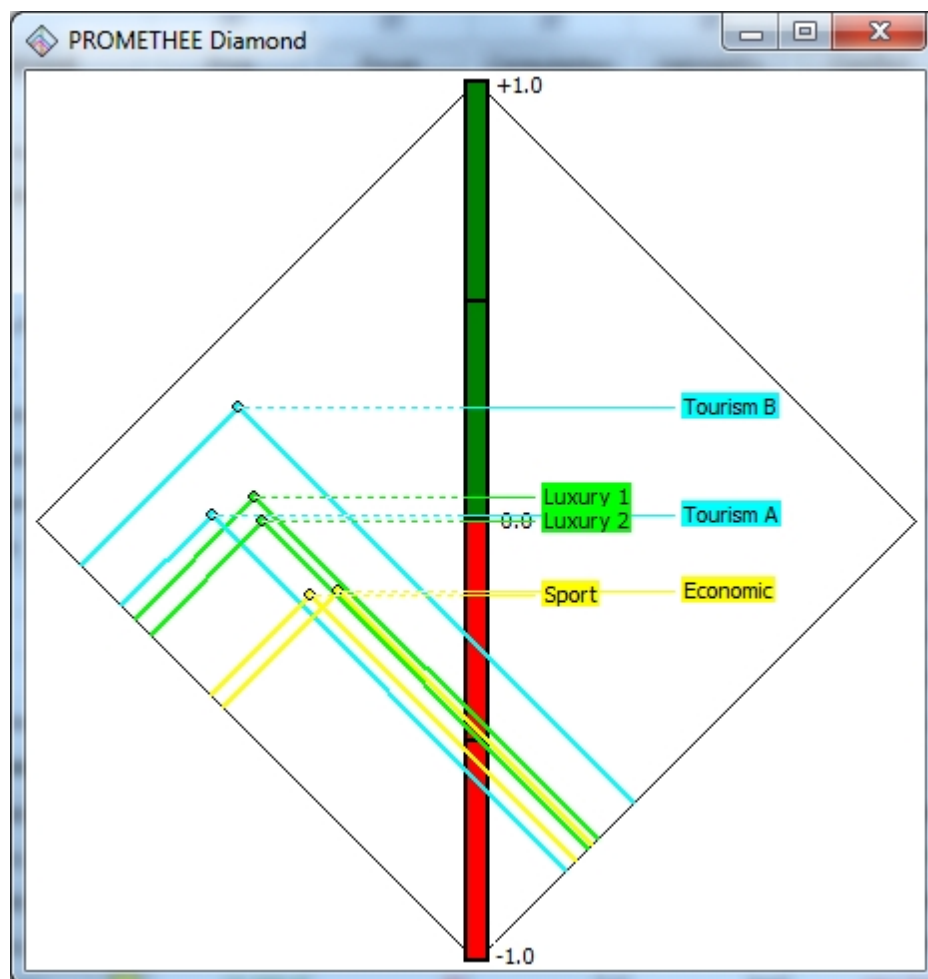
between Φ^+ and Φ^- scores are not visible anymore. Incomparability in the **PROMETHEE I** ranking is interesting because it emphasizes actions that are difficult to compare and thus helps the decision-maker to focus on these difficult cases.

PROMETHEE Diamond

Click **PROMETHEE-GAIA | PROMETHEE Diamond** to open this window.

The [PROMETHEE Diamond](#) is an alternative two-dimensional joint representation of both **PROMETHEE I** and **II** rankings.

The square corresponds to the (Φ^+, Φ^-) plane where each action is represented by a point. The plane is angled 45° so that the vertical dimension gives the Φ net flow. Φ^+ scores increase from the left to the top corner and Φ^- scores increase from the left to the bottom corner.



For each action, a cone is drawn from the action position in the plane.

As the **Tourism B** cone overlaps all the other ones this action is preferred to all the other ones in the **PROMETHEE I** partial ranking.

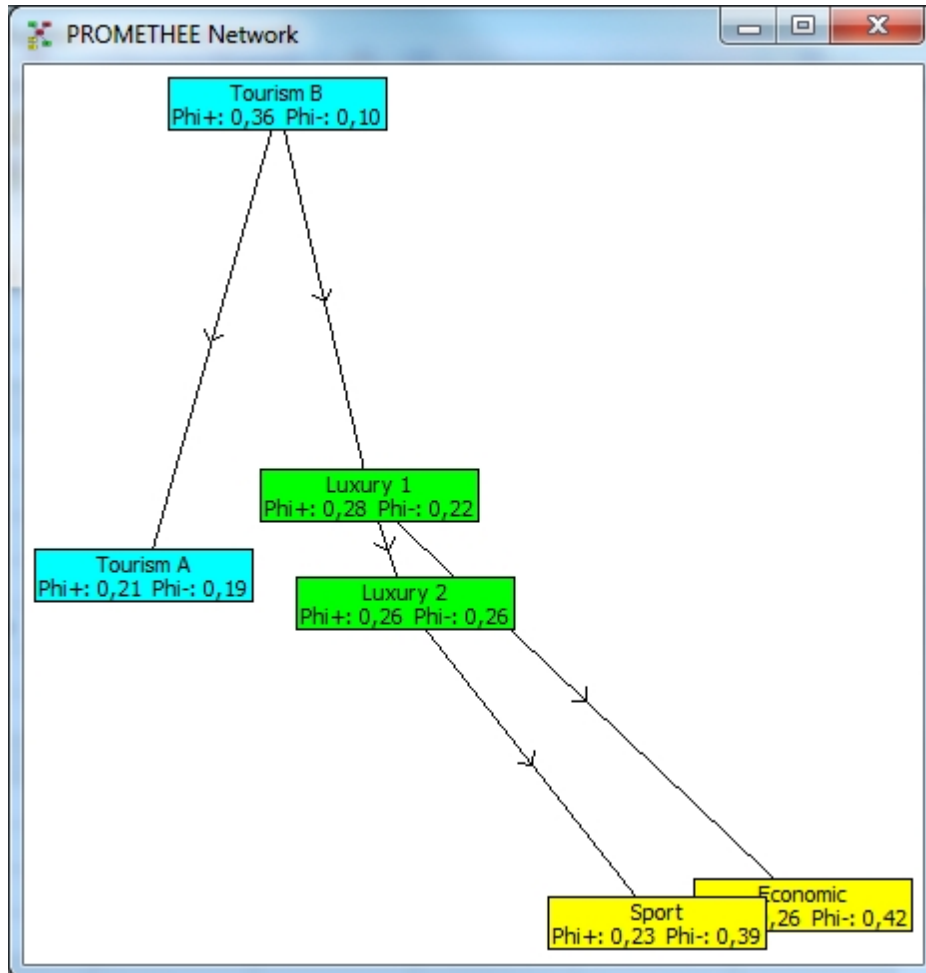
On the contrary the intersecting yellow cones corresponding to **Sport** and **Economic** indicate an incomparability.

An advantage of the **PROMETHEE** Diamond is that it is easy to visualize the proximity between Φ^+ and Φ^- scores globally.

PROMETHEE Network

Click "**PROMETHEE-GAIA | PROMETHEE Network**" to open this window.

The [PROMETHEE Network](#) representation of the **PROMETHEE I** Partial Ranking will feel familiar to the users of older **PROMETHEE** software such as **PromCalc** or **Decision Lab**. Actions are represented by nodes and arrows are drawn to indicate preferences. Incomparabilities are thus very easy to detect.

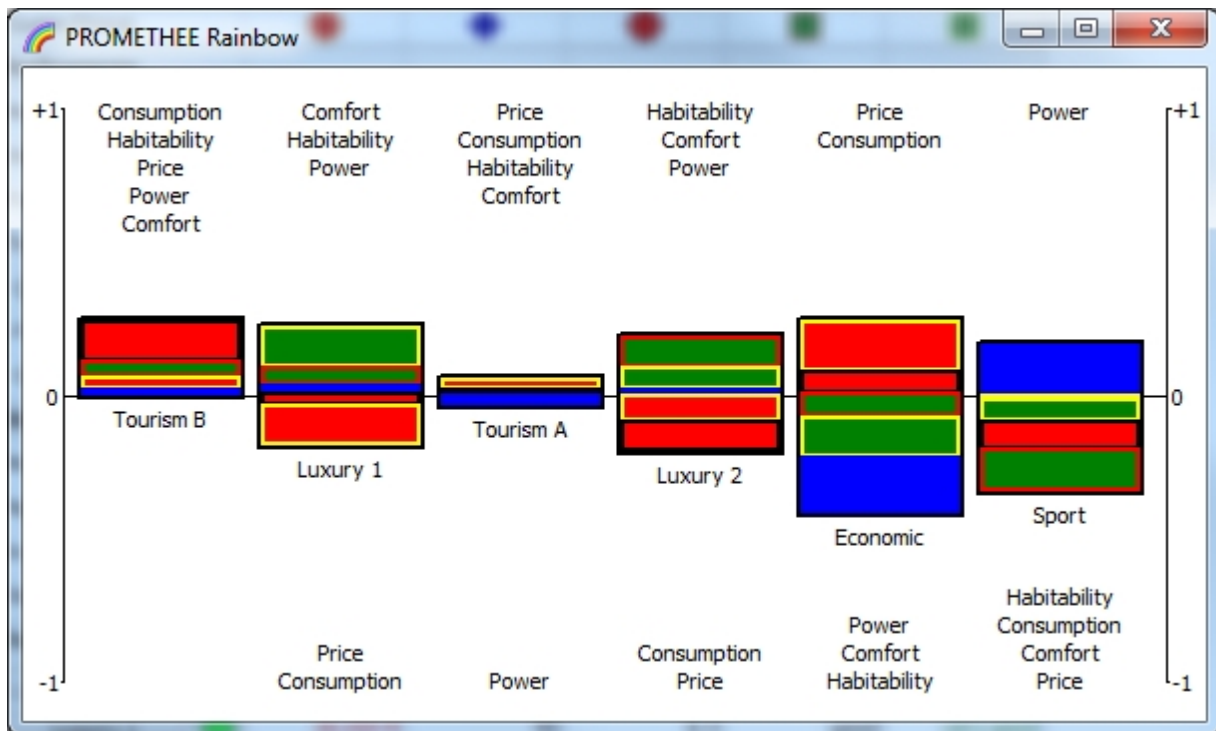


Visual PROMETHEE uses an enhanced network representation: instead of drawing the nodes at arbitrary locations the relative positions of the actions in the **PROMETHEE Diamond** are used. The network representation is like a close-up of the **Diamond** view where preferences are indicated by arrows. This makes it very straightforward to appreciate the proximity between actions and thus the degrees of incomparability in the partial ranking.

PROMETHEE Rainbow

Click "**PROMETHEE-GAIA | PROMETHEE Rainbow**" to open this window.

The [PROMETHEE Rainbow](#) is a disaggregated view of the **PROMETHEE II** complete ranking.



Actions are displayed from left to right according to the **PROMETHEE II** ranking: **Tourism B** to **Sport**.

For each action the stacked slices show the components of the action net flow. For instance:

- **Tourism B** exhibits no negative slices as all criteria contribute positively to its net flow score. This action presents no weaknesses with respect to the other actions. The larger red slice indicates that **Consumption** is the most important feature of this action. Its Phi score is positive.
- **Tourism A** has very small slices. It has no real weakness but also no real advantage. It is quite average. Its Phi score is close to zero.
- **Economic** is much more of a mixed bag with a very good **Price** (the upper red slice) and a very low **Power** (the lower blue slice). Globally, the negative slice more than compensate the positive ones and the Phi score is negative.

PROMETHEE Table

Click **PROMETHEE-GAIA | PROMETHEE Table** to open this window.

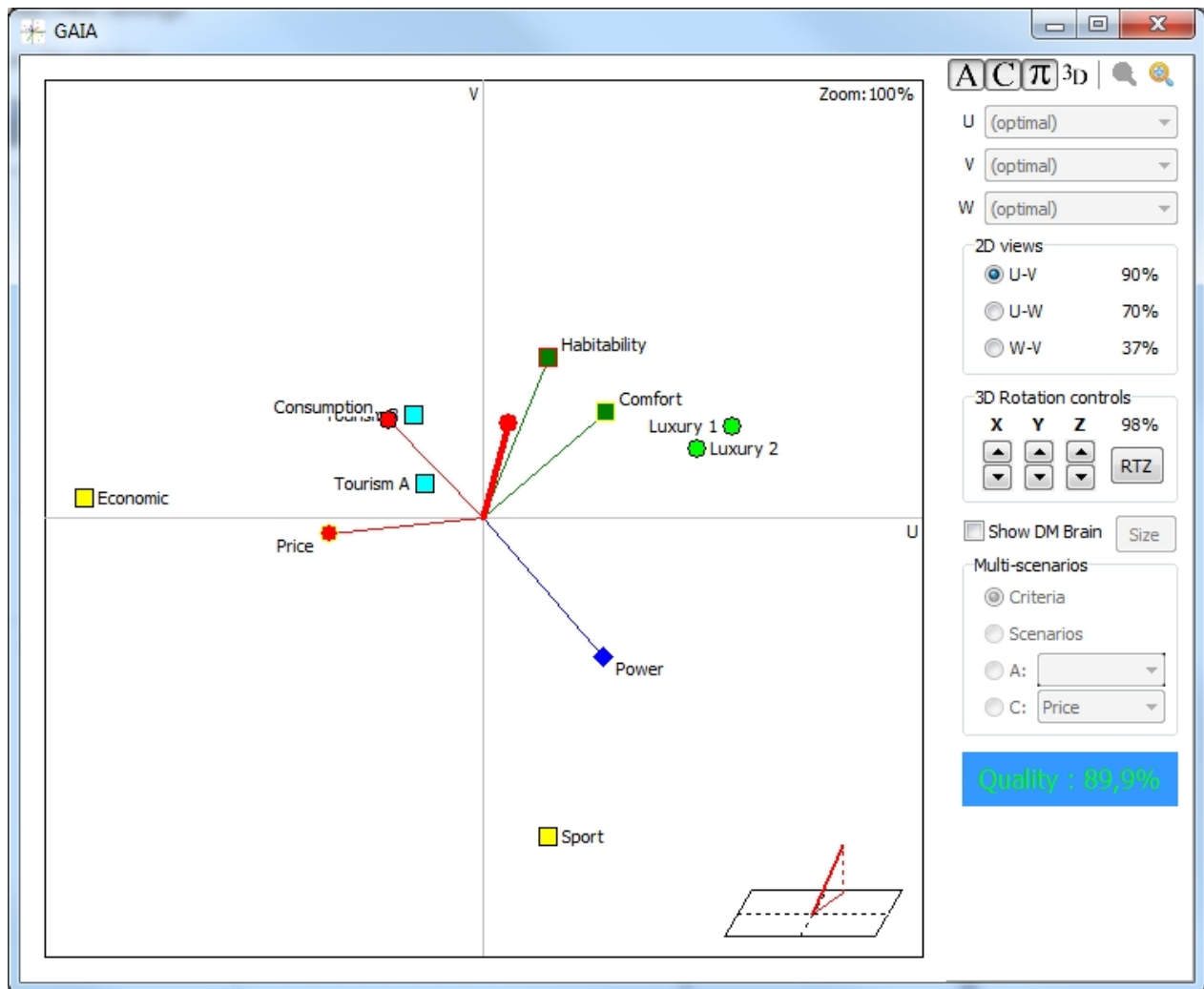
PROMETHEE Flow Table				
	Car	Phi	Phi+	Phi-
1	Tourism B	0.2573	0.3573	0.1000
2	Luxury 1	0.0547	0.2760	0.2213
3	Tourism A	0.0133	0.2060	0.1927
4	Luxury 2	-0.0013	0.2560	0.2573
5	Economic	-0.1573	0.2647	0.4220
6	Sport	-0.1667	0.2280	0.3947

The [PROMETHEE Table](#) displays the Phi, Phi+ and Phi- scores. The actions are ranked according to the **PROMETHEE II** complete ranking. This can be handy when the number of actions is large or to export the data to another program such as e.g. Excel (right-click the table to open the local menu and select **Copy** to copy the data to the clipboard).

The GAIA plane

The **GAIA** plane is a descriptive complement to the **PROMETHEE** rankings.

Click "**PROMETHEE-GAIA | GAIA Visual Analysis**" to open this window.



The [GAIA](#) analysis displayed when **Visual PROMETHEE** launches is a standard 2D (U,V) analysis.

GAIA starts from a multidimensional representation of the decision problem with as many dimensions as the number of criteria (five in this tutorial). A mathematical method called the Principal Components Analysis is used to reduce the number of dimensions while minimizing the loss of information.

In **Visual PROMETHEE** three dimensions are computed:

- U is the first principal component, it contains the maximum possible quantity of information,
- V is the second principal component, providing the maximum additional information orthogonal to U,
- W is the third principal component, providing the maximum additional information orthogonal to both U and V.

The standard **GAIA** analysis includes U and V only, as in older software such as PromCalc, Decision Lab, D-Sight or Smart Picker Pro. **Visual PROMETHEE** adds a third W component to improve the analysis when the (U,V) representation quality is too low.

The U, V, W list boxes are not functional yet. Currently optimal representations only are available.

The 2D views controls allow to switch between three 2D views:

- U-V: This is the best possible 2D view. In this tutorial it gathers 90% of information.
- U-W: With respect to the U-V view, it is viewed from the side (W is orthogonal to both U and V), it is of lower quality and it gathers only 70% of information in this tutorial.
- W-V: With respect to the U-V view, it is viewed from the top, it is thus the lowest quality 2D view available in **Visual PROMETHEE** and it gathers here only 37% of information.

Look at how the quality level is displayed at the bottom right of the window: its color changes from green to red to indicate the level of quality. Lower levels such as in the W-V plane make it difficult to draw reliable conclusions from the **GAIA** plane. In practice the 2D **GAIA** analysis is reliable when the quality level is above or close to 70%.

The above screenshot shows the U-V plane. It contains three types of information:

1. [Actions](#) are represented by points.
2. [Criteria](#) are represented by axes.
3. The [weighing](#) of the criteria and the **PROMETHEE II** ranking are represented by the **decision axis**.

Actions

Each action is represented by a point in the **GAIA** plane. Its position is related to its evaluations on the set of criteria in such a way that actions with similar profiles will be closer to each other. In this tutorial example we can identify four different types of profiles:

- Luxury cars (**Luxury 1** and **2**) are very close to each other. They are quite similar actions.
- Tourism cars (**Tourism A** and **B**) are also close to each other. They are also similar actions.
- The **Economic** car is on its own. It seems quite different from the other actions.
- The **Sport** car is also very different from the other actions.

To better understand the differences between these four groups of actions, we can have a look at the criteria.

Criteria

Each criterion is represented by an axis drawn from the center of the **GAIA** plane. The orientation of these axes is important as they indicate how closely the criteria are related to each other:

- Criteria expressing similar preferences have axes that are close to each other.
- Conflicting criteria have axes that are pointing in opposite directions.

It is thus possible to identify groups of criteria expressing similar preferences and to better understand the conflicts that have to be solved in order to make a decision. In this tutorial, three such groups can be identified:

- **Habitability** and **Comfort** are close to each other. This means that based on the data cars exhibiting a higher comfort level have also a higher habitability level. It is thus possible to find solutions (cars) that are good on both criteria at the same time. These criteria could be associated to the general objective of "**Luxury**".
- **Price** and **Consumption** are also relatively close to each other. So we can expect cheaper car to be more fuel efficient. Or... more expensive cars to be less fuel efficient. These two criteria could be associated to a general objective of "**Economy**".
- Finally, **Power** is on its own and seems to be conflicting with most other criteria.

Given the different orientation of the three aforementioned groups, we can conclude that the decision maker will have to conciliate three conflicting objectives: luxury, economy and power.

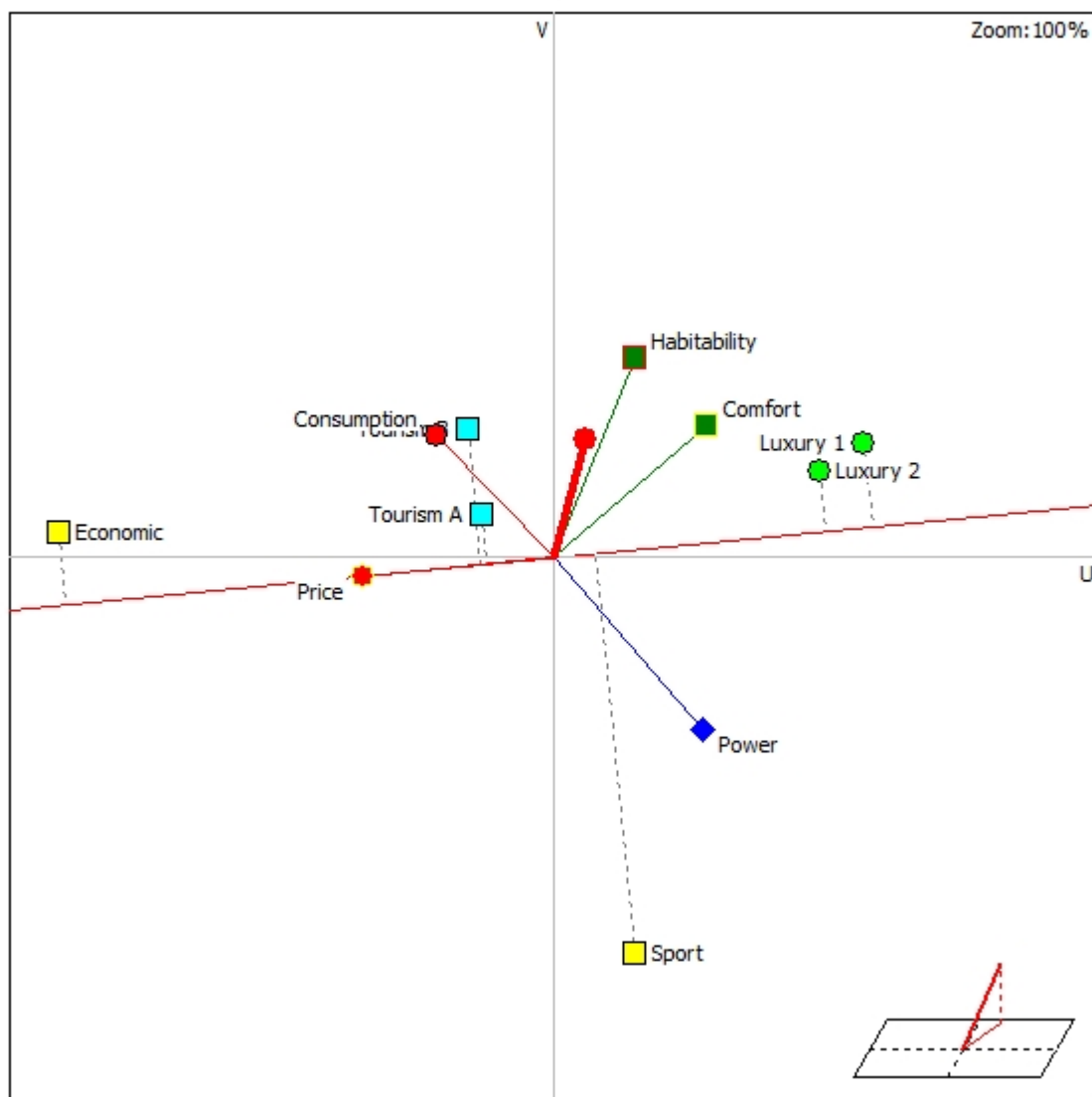
The length of the criteria axes is also relevant. Indeed the longer an axis the more discriminant the criterion. For instance the axis for **Power** is longer than the axis for **Consumption**: the range for **Power** is 60 kW (twice the P threshold for that criterion) while the range for **Consumption** is 2L (once the P threshold). The variations observed on the **Power** criterion are thus felt more important for the decision maker than variations observed on criterion **Consumption**. Discrimination is different from the weight of the criterion. The **Price** criterion can be very important for the decision maker but if all prices are in a 100€ range this criterion will not be discriminant at all.

Actions and criteria

The relative positions of actions and criteria are also interesting to analyze.

Indeed the orientation of a criterion axis indicates where the best actions for this criterion are located.

Let us take criterion **Price** as an example. Right-click on the **GAIA** plane to open the local menu and select "Show axis | Price". A line is drawn along the **Price** axis and the actions are projected orthogonally to that line.



What is important is not how far an action is from the criterion axis but rather how it projects itself on the direction of the axis. In this tutorial example, we see that:

- **Economic** is clearly the cheapest car as it projects completely to the left side.
- **Tourism A** and **B** are the second best choices with respect to **Price**. They are very close to each other.
- **Sport** is slightly more expensive than the Tourism cars.
- **Luxury 1** and **2** are very close to each other and are the most expensive cars.

This information is of course highly dependent on the quality of the **GAIA** plane. For lower quality level one can expect more distortions with respect to actual evaluations. Indeed a lower quality level means that it is more difficult to have an accurate 2D representation of the multicriteria problem.

Looking globally at the different criteria it is now possible to better explain the different action profiles:

- Luxury cars (**Luxury 1** and **2**) are good on **Comfort** and **Habitability** and not so bad on **Power**. But they are weak on **Price** (expensive) and **Consumption**.
- Tourism cars (**Tourism A** and **B**) are more average (central) cars.
- The **Economic** car is the best for **Price** (it is the cheapest), it is good on **Consumption** but really bad on the other criteria.
- The **Sport** car is the most powerful one. But that is its only good feature.

Decision Axis

The decision axis (the thicker red axis) is a representation of the weighing of the criteria. It is similar to a criterion axis but for an important point: the representation of the decision axis is not optimal. When the weight of the criteria are modified, the **GAIA** plane is not. Only the decision axis is modified. Thus shorter decision axes are less reliable.

The orientation of the decision axis indicates which criteria are in agreement with the **PROMETHEE** rankings and which are not. In this tutorial, the decision axis is opposite to the **Price** and **Power** criteria which means that one can expect to find rather expensive and not so powerful cars at the top of the **PROMETHEE** rankings. If this is not consistent with the decision maker objectives it probably means that these criteria have been under-weighted.

The decision axis can thus be used as a tool to analyze the type of compromise corresponding to the current weighing of the criteria and to help to better define the weights of the criteria.

The decision axis is actually the projection of the **Decision Stick** (i.e. the axis representing the weights of the criteria in the criteria space) onto the **GAIA** Plane. A three-dimensional representation of the Decision Stick can be displayed in the [GAIA window](#) (at the lower right corner in the above screenshots).

Additional analysis

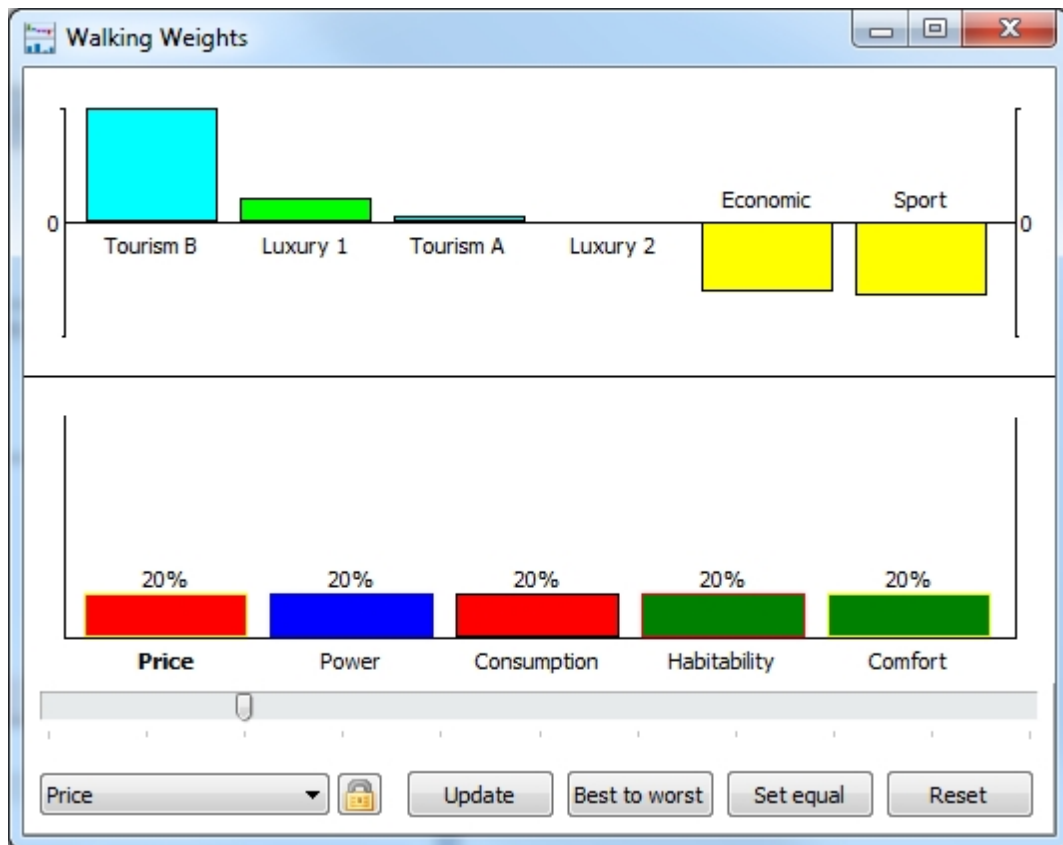
The [GAIA window](#) includes many other analysis possibilities that are described in the corresponding [page](#). More information about the theoretical foundations of **GAIA** can also be found [here](#).

The Walking Weights

Visual PROMETHEE provides you with several tools to perform an extensive weight sensitivity analysis on your data.

Walking Weights

Click "**PROMETHEE-GAIA | Walking Weights**" to open this window.



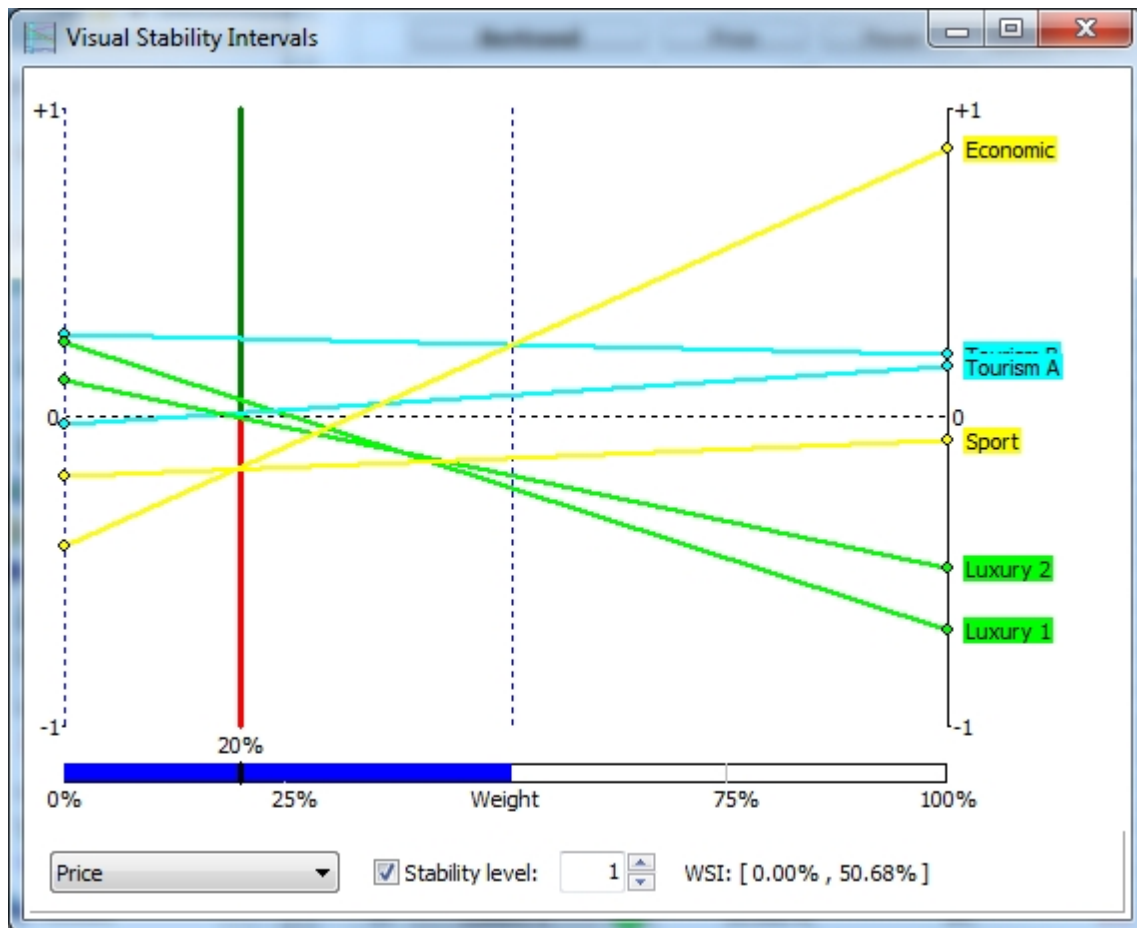
The **Walking Weights** window allows you to change the weights of the criteria and see the impact on the **Visual PROMETHEE** analysis.

The window is split into two parts:

- The upper part is a bar chart showing the **PROMETHEE II** Complete Ranking.
- The lower part is a bar chart showing the weights of the criteria.

The slider allows to change the weight of the selected criteria and to see the impact on the **Visual PROMETHEE** analysis. All opened windows are automatically updated.

A more precise and thorough weight stability analysis can be done using the [Visual Stability Intervals](#). The screenshot below shows the visual stability analysis for criterion **Price**.



The horizontal axis is the weight of the criterion from 0% to 100%.

The vertical axis is the **PROMETHEE** net flow.

For each active action a line is drawn that shows how the net value change when the weight of the criterion is modified. In this case it can be seen that **Tourism B** is at the top of the **PROMETHEE II** ranking for a wide range of weight.

Working with multiple scenarios

To learn about working with multiple scenarios in **Visual PROMETHEE** you are first going to load another dataset.

In the [Main Menu](#), click **File** and then **Open**. Find the **TutorSites.vpg** file (it should be located in the **Visual PROMETHEE** install folder) and open it.

Visual PROMETHEE Business - TutorSites.vpg (saved)							
File Edit Model Control PROMETHEE-GAIA GDSS GIS Custom Assistants Snapshots Options Help							
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Industrial	Investment	Operations	Employment	Transportation	Environ. Imp.	Social Imp.
Unit		M\$	M\$	workers	5-point	impact	impact
Cluster/Group		◆	◆	◆	◆	◆	◆
Preferences							
Min/Max		min	min	min	max	min	min
Weight		25.00	15.00	20.00	20.00	10.00	10.00
Preference Fn.		Linear	Linear	Linear	Level	Level	Level
Thresholds		percentage	percentage	percentage	absolute	absolute	absolute
- Q: Indifference		0.05	0.05	0.05	0.5	0.5	0.5
- P: Preference		0.25	0.25	0.1	1.5	1.5	1.5
- S: Gaussian		n/a	n/a	n/a	n/a	n/a	n/a
Statistics							
Minimum		74 €	7 €	95	2.0	1.0	1.0
Maximum		128 €	12 €	175	5.0	4.0	4.0
Average		98 €	9 €	139	3.6	2.4	2.2
Standard Dev.		20 €	2 €	32	1.0	1.0	1.2
Evaluations							
<input checked="" type="checkbox"/> Site 1		74 €	12 €	175	average	high	low
<input checked="" type="checkbox"/> Site 2		86 €	9 €	170	good	low	very low
<input checked="" type="checkbox"/> Site 3		89 €	7 €	145	very good	very low	moderate
<input checked="" type="checkbox"/> Site 4		115 €	8 €	95	bad	low	high
<input checked="" type="checkbox"/> Site 5		128 €	10 €	110	good	moderate	very low
<input checked="" type="checkbox"/> All <input checked="" type="checkbox"/> Industrial <input checked="" type="checkbox"/> Political <input checked="" type="checkbox"/> Environmental <input checked="" type="checkbox"/> Social							
Actions: 5 (5 active) Criteria: 6 (6 active) Scenarios: 4 (4 active) Locale: Belgium [€/.] Saved							

This dataset corresponds to a location problem. An industrial company wants to build a new plant and hesitates between five different locations (**Site 1** to **Site 5**).

Six criteria are considered relevant to compare the five locations:

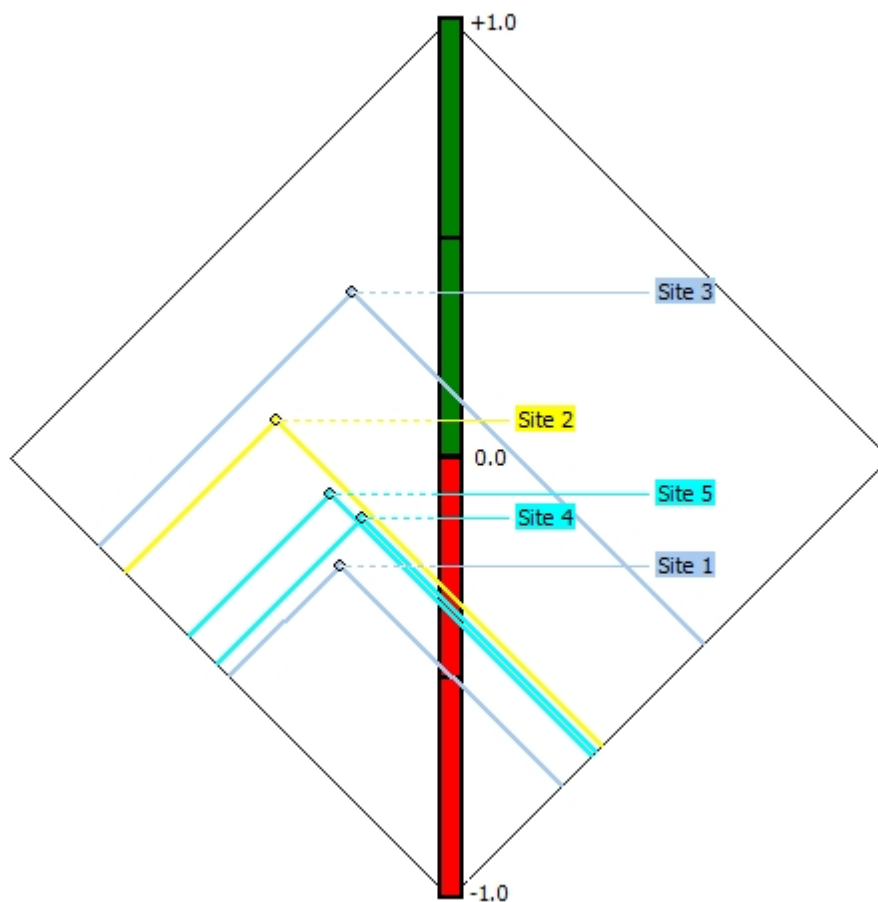
- **Investment:** This is the investment cost in million Euros. It should be minimized.
- **Operations:** This is the annual operating cost. It is also expressed in million Euros and has to be minimized as well.
- **Employment:** This is the number of workers required to run the plant. Different locations correspond to different plant configuration or different technologies, so the choice has an impact on that number. As it is linked to salaries and to social costs, this criterion should be minimized.
- **Transportation:** This is a qualitative criterion that evaluates the site adequacy with respect to transportation. It encompasses factors such as the proximity to transportation networks, the distance to suppliers and to customers, etc. It is expressed on a 5-point scale (very bad to very good).
- **Environment:** This is a global evaluation of the environmental impact, on a 5 point impact scale: from very low (best) to very high (worst).
- **Social:** This is a global evaluation of the social impact, on the same 5 point impact scale: from very low (best) to very high (worst).

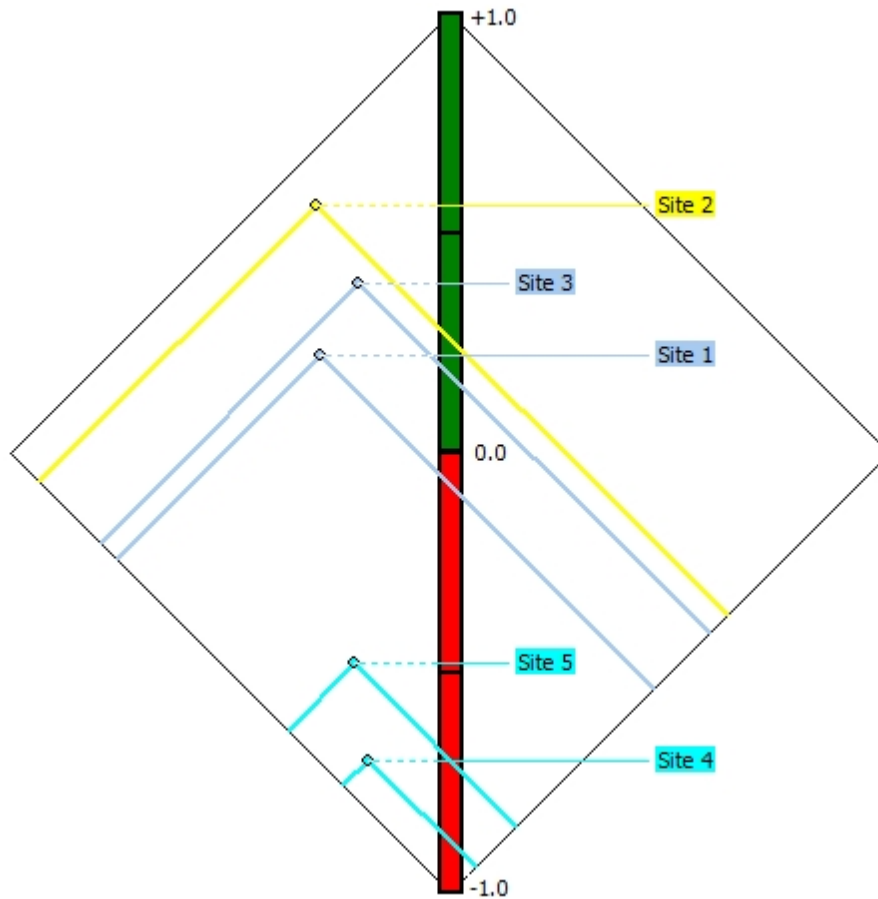
At the bottom of the spreadsheet, there are five tabs corresponding to five different scenarios. Each scenario represents the point of view of one stakeholder:

- **Industrial:** This is the point of view of the actual decision maker, of the company that wants to build the new plant.
- **Political:** This is the point of view of the regional political authority that has to allow the permit for building the plant.
- **Environmental:** This is the point of view of environmental associations within the region. They have some influence on the industrial decisions made in the region.
- **Social:** This is the point of view of the worker's unions. They also have some influence on industrial decisions as these are linked to the creation of jobs in the region.

Click on the tabs to switch from one scenario (point of view) to another. As you can see the preference parameters and even the criteria evaluations for more subjective criteria do change from one scenario to another.

The complete **Visual PROMETHEE** analysis is performed separately for each scenario. Here are the **PROMETHEE Diamonds** for scenarios **Industrial** (left) and **Social** (right):

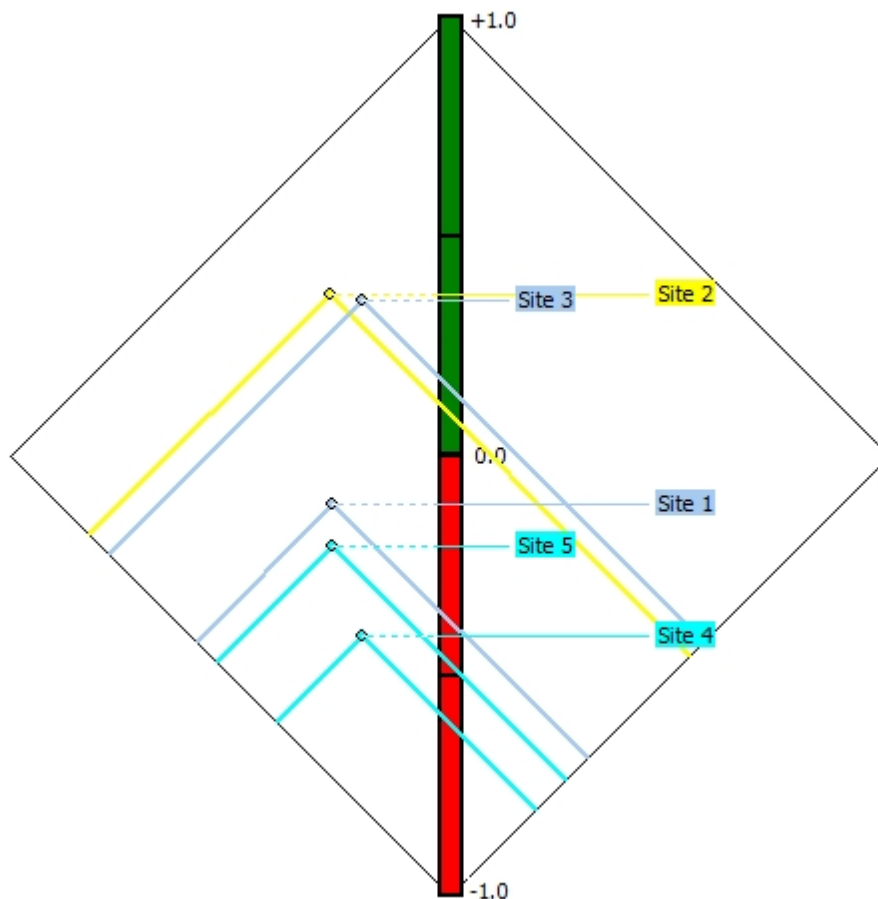




For the **Industrial** scenario, **Site 3** is clearly the best choice, and **Site 1** is the worst one. There is a slight incomparability between **Site 5** and **Site 4**.

For the **Social** scenario, there is no incomparability and **Site 2** is the preferred choice. There is also a wider spread between the best and worst actions. That means that stronger preferences are expressed to differentiate actions in this scenario.

The "**All**" tab can be selected to perform the analysis on all the scenarios at the same time. In this case the [weighing](#) of the scenarios is taken into account to produce a consensus **PROMETHEE** ranking and several **GDSS** analyses. Here is the **PROMETHEE Diamond** for the consensus ranking:

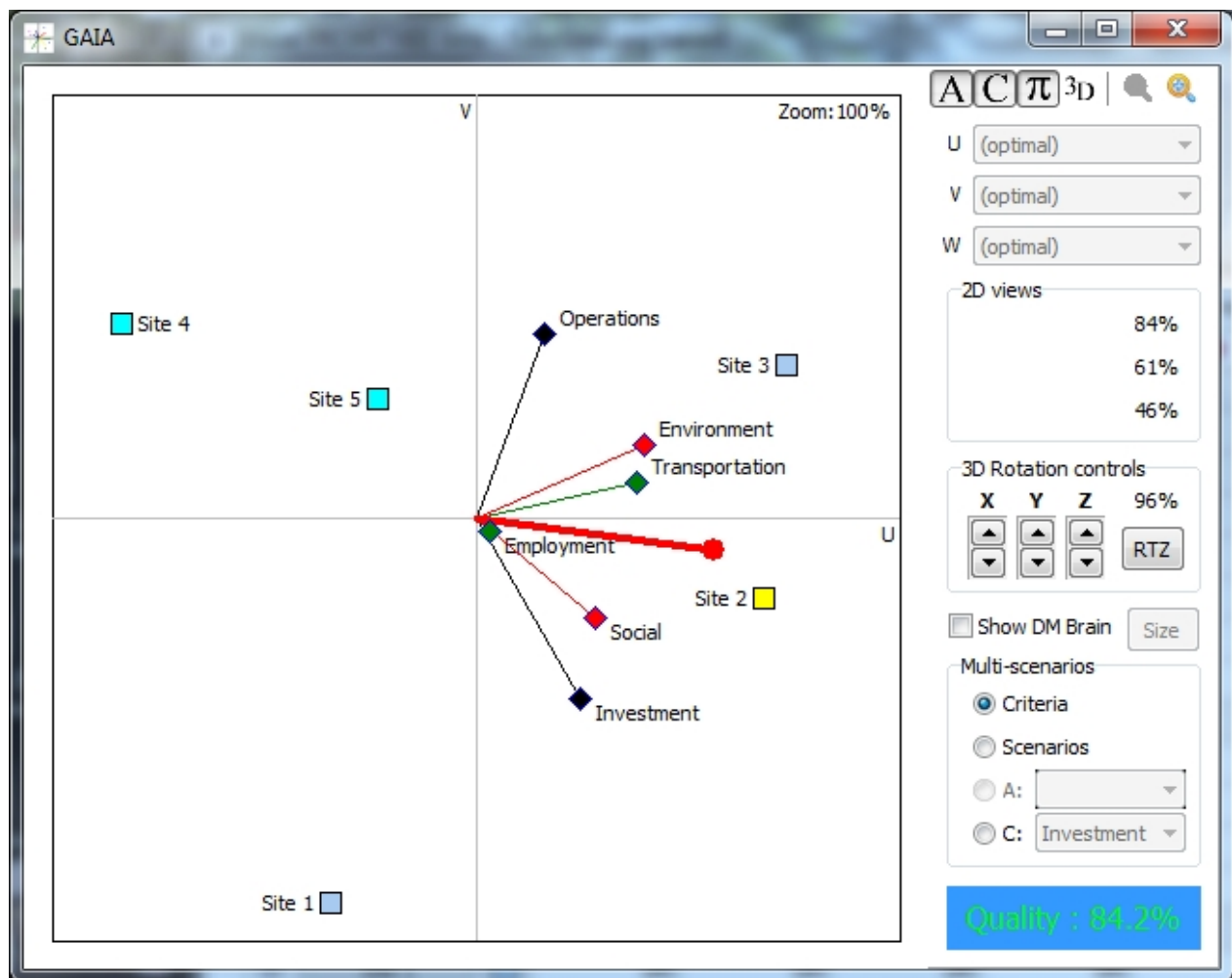


Two actions appear clearly at the top of the ranking: **Site 2** and **Site 3**. They are incomparable in **PROMETHEE I**. That can be explained easily: **Site 2** is the best choice for scenarios **Environmental** and **Social** while **Site 3** is the best for scenarios **Industrial** and **Political**. It is thus very difficult to choose between these two actions. That is reflected in the **PROMETHEE I** partial ranking.

Besides the **PROMETHEE** rankings there are several **GDSS** extensions to the **GAIA** analysis that can be helpful to better understand the different points of view in a **GDSS** context. When the "All" scenarios tab is selected in the **Visual PROMETHEE** spreadsheet the following four "Multi-scenarios" options become available on the right side of the **GAIA** window:

- **Criteria**

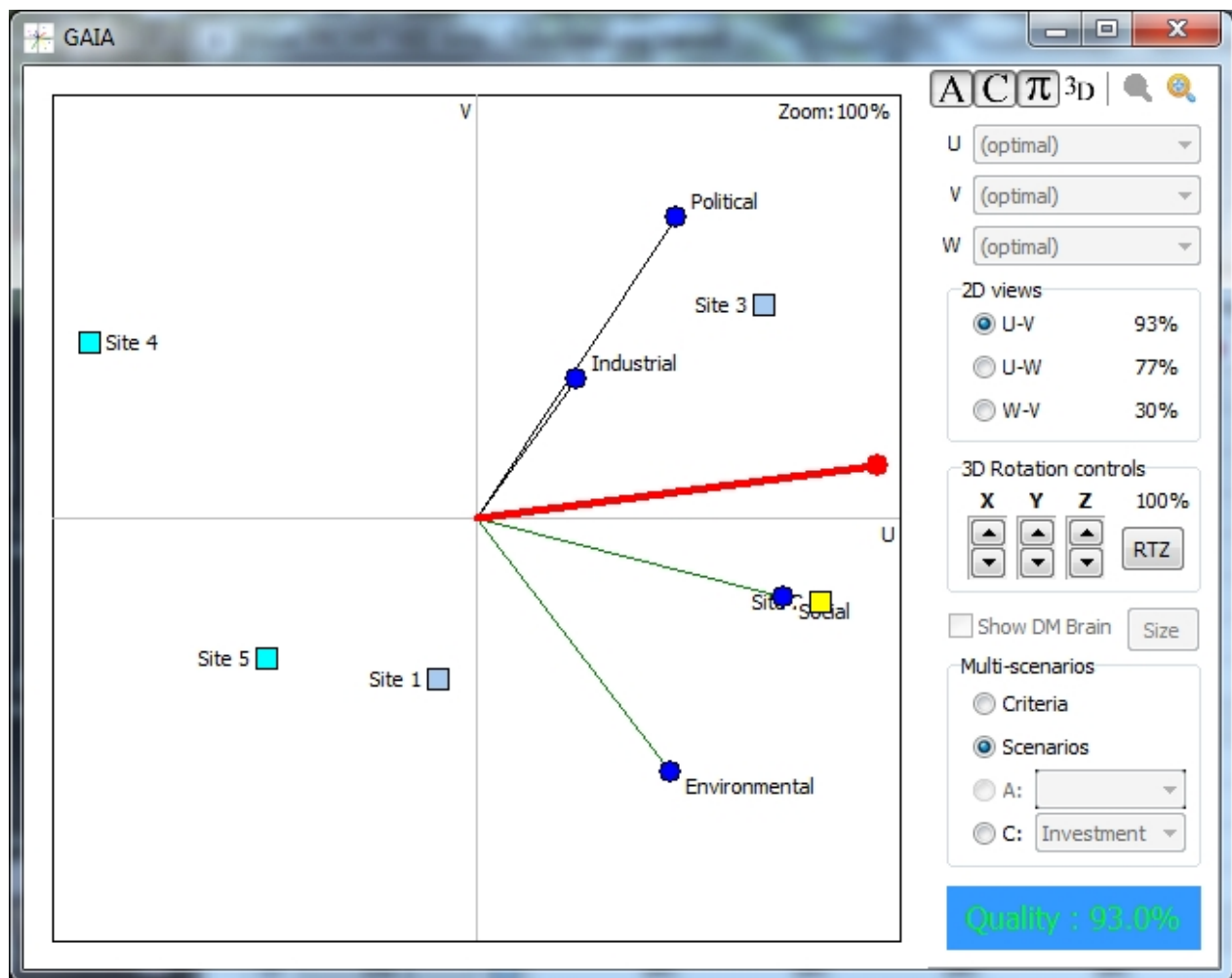
This is the regular **GAIA-Criteria** display where axes correspond to the criteria (or groups). In the **GDSS** context however this display will not show any evaluation differences between scenarios. Instead "average" evaluations will be shown. This can be misleading in case of subjective evaluations. Here is the **GAIA-Criteria** plane for the tutorial example:



There are not so many conflicts apparent as all criteria axes are oriented to the right. **Site 2** and **Site 3** also appear to be the best choices globally. But no information is available on the way each criterion has been evaluated by the different decision makers.

- **Scenarios**

In this **GAIA-Scenarios** analysis axes correspond to the scenarios. They show the disagreements between the different scenarios. Here is the result for the tutorial example:



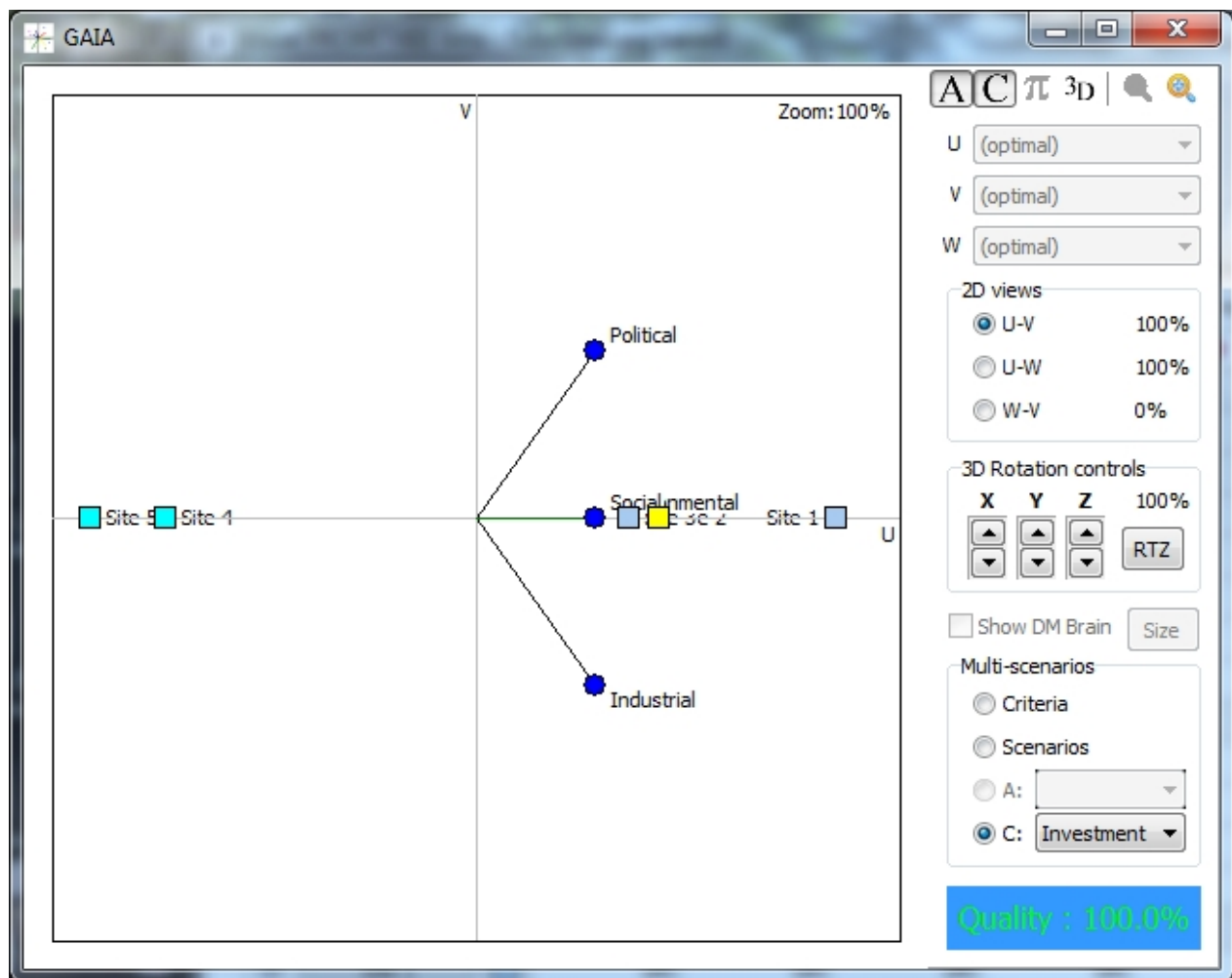
Two groups of decision makers appear: **Industrial** and **Political** are very close to each other and prefer **Site 3** while **Environmental** and **Social** prefer **Site 2**. Globally there is no very strong conflict as all the axes are oriented to the right.

- **A: single action**

This analysis is not implement yet.

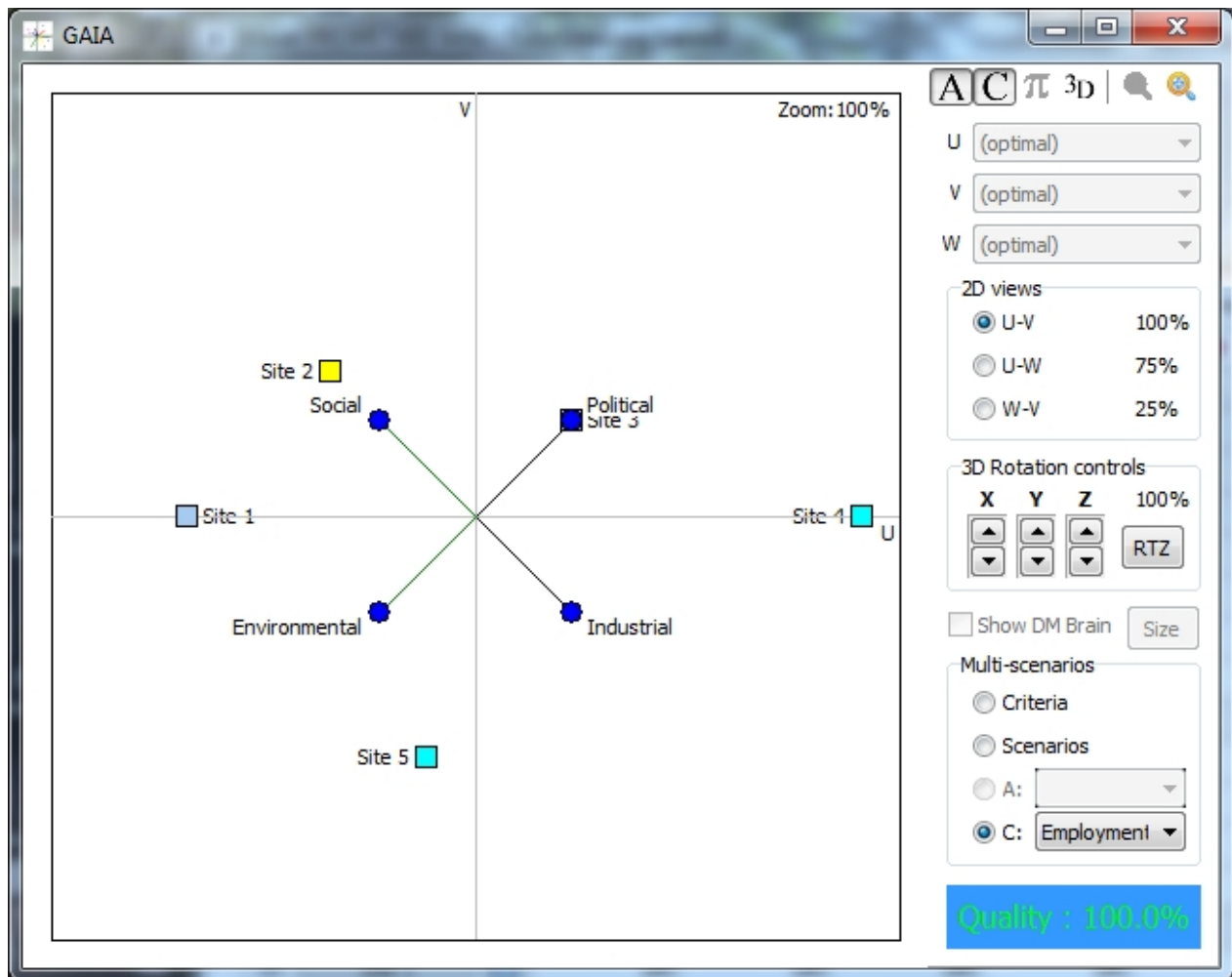
- **C: single criterion**

In the **GAIA-Unicriterion** analysis a single criterion is compared over the different scenarios. This can be helpful to identify the sources of disagreement within a group of decision makers. Here are two very different examples. First the **Investment** criterion is selected.



This is an "objective" criterion for which the evaluations are the same in all the scenarios. The only differences can arise from the choice of the preference functions. In this case, all the actions are on a straight line as they are evaluated in the same way in all the scenarios.

For the second example the criterion **Employment** has been selected. The positions of the axes indicate that this criterion has been evaluated very differently in the four scenarios.



- **Site 4** is preferred by **Political** and **Industrial**. But not by **Environmental** and **Social**.
- **Site 1** and **Site 5** are preferred by **Environmental** but not at all by **Political**.

This shows that this criterion is evaluated very differently from one decision maker to another. Possibly because they do not understand the definition of the criterion in the same way. This can be a source of conflict and can make the decision making process more difficult. The **GAIA-Unicriterion** analysis can help to discover such situations and be a basis for establishing a better discussion basis: for instance the definition of the criterion could be modified or the criterion could be split into sub-criteria or the evaluation could be reviewed by the decision maker.

Several additional tools are also available in the **GDSS** context:

- [Scenarios comparison](#)
- [Balance of Power](#)

Advanced features

Visual PROMETHEE includes several more advanced or more specialized tools:

- **Action Profiles**: a disaggregated view of the strengths and weaknesses of an [action](#). Multiple windows make it possible to compare up to five actions.

- [GAIA Webs](#): an alternate profile view that relies on the **GAIA** analysis to draw spider-web charts that are easier to understand. Multiple windows make it possible to compare up to five actions.
- [PROMETHEE V Multiple Selection](#) under Constraints: Sometimes the problem is not to identify the "best" action but rather to select a "best" subset of actions according to additional constraints such as budget limits or diversification. This is sometimes known as portfolio analysis (in the context of R&D projects for instance)
- [PROMETHEE Sort](#): can be used to sort the action into predefined [classes](#). The classes can be either ordered or not. They can be defined by either boundary or central [profiles](#).
- [Bank Adviser](#):
- [Performance Analysis](#): This is a DEA-like analysis where two [clusters](#) of criteria are compared: input criteria and output criteria. An efficiency measurement is derived from the **PROMETHEE** analysis of the two clusters of criteria. A graphical analysis (efficient frontier) is also available.
- [PROMap GIS Integration](#): When the actions are geolocalized it is possible to set their position using a Google Maps interface from the [Actions](#) dialog and to display the **PROMETHEE** or **GAIA** results on the map with [PROMap](#).

Besides there are several data management tools that can be useful:

- [Activation Center](#): a central place to control easily the activation of [actions](#), [categories](#), [criteria](#), [groups](#), [clusters](#), [scenarios](#) and [coalitions](#).
- [Filters](#): to automatically deactivate actions based on criteria minimum or maximum values.
- [Sort](#): to change the display order of [actions](#), [categories](#), [criteria](#), [groups](#), [clusters](#), [scenarios](#) or [coalitions](#).
- Snapshots:
 - [Weight Presets](#): to save up to five different criteria weightings for easy comparison.
 - [Layouts](#): to save up to five different windows layouts for specific analyses.

There are also four **Assistants** that can help you to set up your decision problem and to analyze it correctly:

- [Creation Assistant](#)
- [Hierarchy Assistant](#)
- [Weighing Assistant](#)
- [Analysis Assistant](#)

The [Preference Function Assistant](#) is also available from the **Visual PROMETHEE** spreadsheet (select "Help me..." in the Preference Function cell) to help you make the right choice of [preference function](#) and thresholds.

Starting a new problem

Let us go through the process of defining a new problem and analyzing it with **Visual PROMETHEE**.

1. The problem

Aouatif is a young Ph.D. student in biology. She wants to use the **PROMETHEE-GAIA** methodology for her research. She doesn't know which software to use and she decides to make a multicriteria evaluation of the available software.

The following software are available:

- **PromCalc**: a very old piece of software (last century tech) but yet very simple to use, provided you can still install it on a recent computer.
- **Decision Lab 2000**: more recent, but not supported anymore and a bit limited with respect to today's standards.
- **D-Sight**: this newer program is not very nice-looking and it is relatively expensive but is backed

by a "dream team" of young entrepreneurs driving (low end) BMW's... who knows where they will be next year?

- **Smart-Picker Pro**: that's the outsider. Nobody knows where it comes from... It looks OK even if a bit on the rough edge but... is it coming from the dark side of the **PROMETHEE** force?
- **Visual PROMETHEE**: the newest and most complete implementation of the **PROMETHEE** and **GAIA** methods, but still in a late beta stage.
- **DIY**: of course Aouatif could also develop her own software using MS Excel, MathLab or a programming language. (for non-English speakers: DIY = Do It Yourself)

2. The model

- **The actions**

The [actions](#) of the problem are the different software available. There are thus six actions.

- **The criteria**

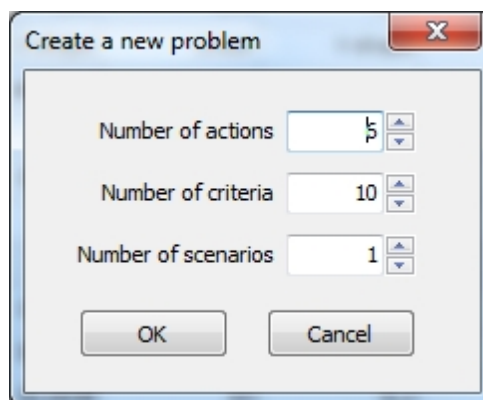
What is important to keep in mind when comparing software? For Aouatif the following criteria should be considered:

- **Price**: how much does it cost?
- **Support**:
 - **Scientific**: is it backed by experts?
 - **Technical**: do they have a sufficient technical support level?
- **Functions**:
 - **Data management**: how easy is it to import/export/manage data?
 - **Analysis**: what types of analyses are available?
- **Interface**: is it easy to use?
- **Installation**: Windows 8 compatible?
- **Documentation**: is documentation available (manual/help/tutorials)?
- **Localization**: is it available in my language?
- **Evolution**: will they still be there next year?

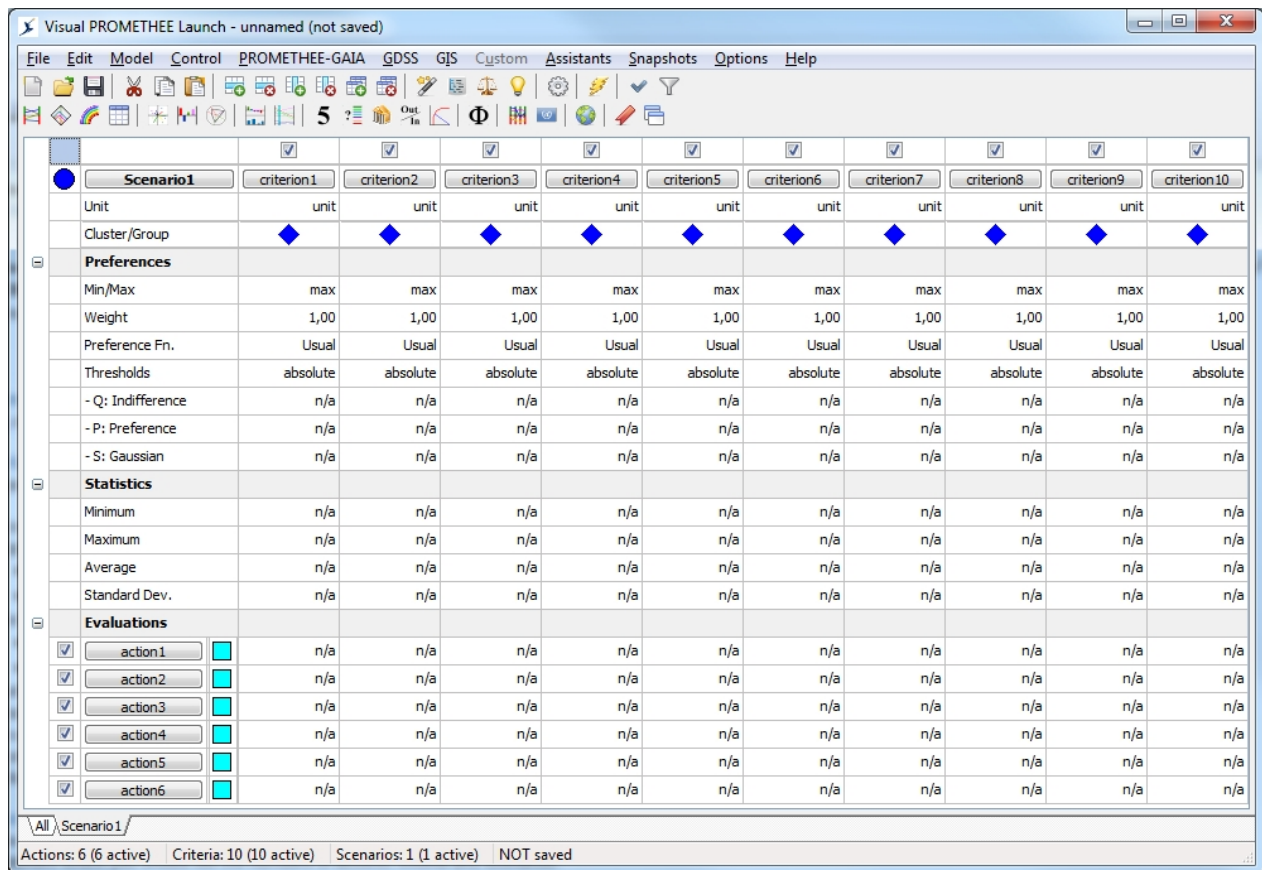
- **Defining a new problem in Visual PROMETHEE**

Let us define a new problem: click the menu item "File | New".

A window appears where you should set the numbers of actions, criteria and scenarios.



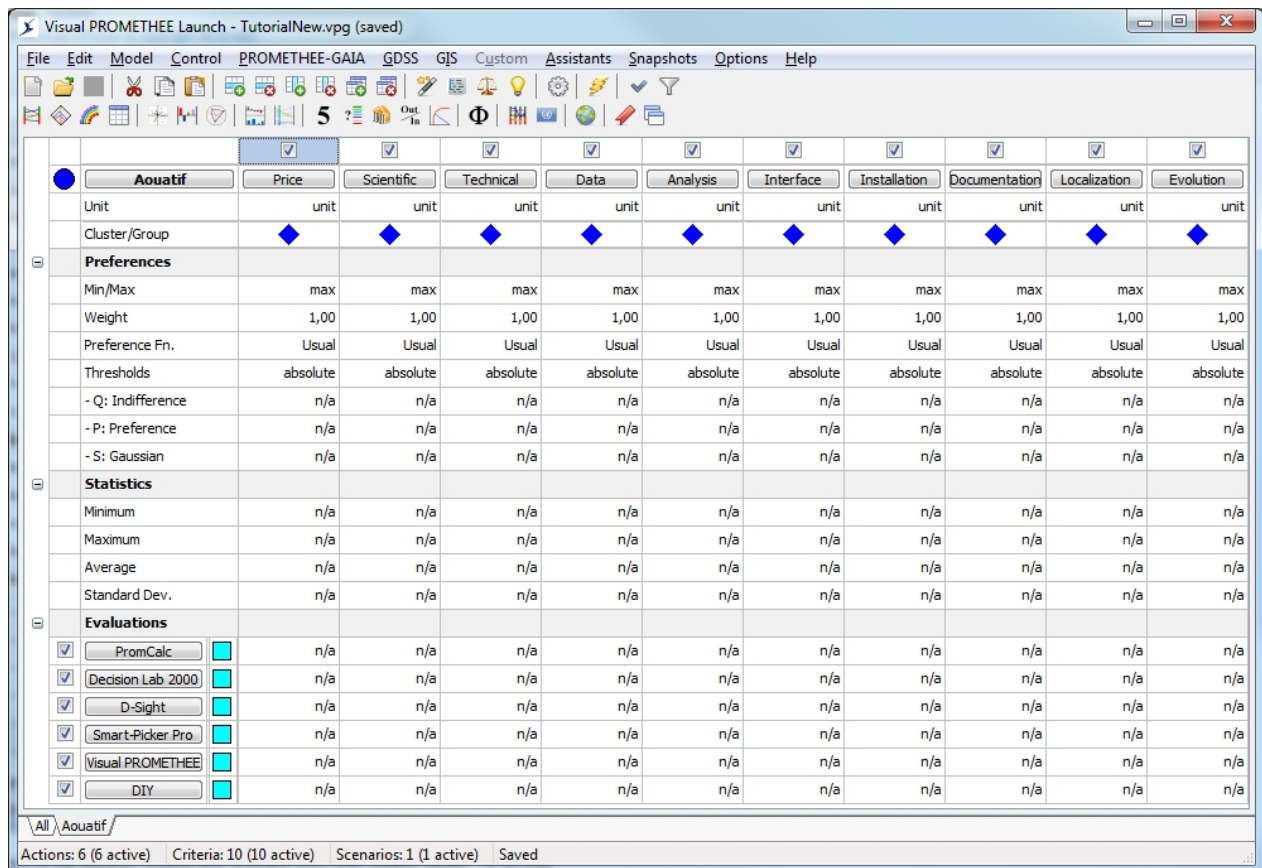
There are six actions (the software to compare), ten criteria and a single scenario (Aouatif is the only one to decide). Adjust the fields as in the above screen-shot and click "OK". An empty spreadsheet appears (see below).



You should first change the names of the actions, criteria and scenario from their default values. To do that:

- for the actions, open the [Actions](#) dialog by either selecting from the menu "Model| Actions..." or clicking on an action name button ("action1", ...) in the spreadsheet.
- for the criteria, open the [Criteria](#) dialog by either selecting from the menu "Model| Criteria..." or clicking on a criterion name button ("criterion1", ...) in the spreadsheet.
- for the scenario, open the [Scenarios](#) dialog by either selecting from the menu "Model| Scenarios..." or clicking on the scenario name button ("Scenario1") in the spreadsheet.

Enter appropriate actions, criteria and scenario names. The resulting spreadsheet should look like the one below.



You still have to enter the evaluations. But...

○ The scales

Before we go further we have to think about scales.

Some are obvious as the **Price** criterion: it is simply the price of the license expressed here in Euros (€). But most others here are qualitative scales and you have first to define them.

For many qualitative criteria a 5-point scale (very good, good, average, bad, very bad) is appropriate. That is why it is predefined in **Visual PROMETHEE**.

To define the scales of the criteria do the following. For each criterion open the **Criteria** dialog by either selecting from the menu "Model|Criteria..." or clicking on a criterion name button ("Price", ...) in the spreadsheet. Then select the right **Scale** type:

- "currency" for the **Price** criterion,
- "qualitative" for the other criteria, once "qualitative" is selected the qualitative scales drop-down list is activated just below the "Scale" field and you should select "5-point" from this list.
- For the **Localization** criterion, it is more simple: it can be localized to your country/ language or not, so you should select the "y/n" (yes/no) scale.

Once the scales are properly defined, the evaluation table can be filled. According to the software characteristics, Aouatif has filled the table as it appears below:

Visual PROMETHEE Launch - TutorialNew.vpg (saved)

File Edit Model Control PROMETHEE-GAIA GDSS GIS Custom Assistants Snapshots Options Help

	Price	Scientific	Technical	Data	Analysis	Interface	Installation	Documentation	Localization	Evolution
Unit	€	5-point	5-point	5-point	5-point	5-point	5-point	5-point	y/n	5-point
Cluster/Group	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Preferences										
Min/Max	max	max	max	max	max	max	max	max	max	max
Weight	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Preference Fn.	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual	Usual
Thresholds	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute
- Q: Indifference	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
- P: Preference	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
- S: Gaussian	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Statistics										
Minimum	0 €	1.00	1.00	1.00	2.00	1.00	1.00	1.00	0.00	1.00
Maximum	249 €	5.00	4.00	5.00	5.00	5.00	5.00	5.00	1.00	5.00
Average	88 €	3.33	2.00	3.33	3.00	3.00	2.83	2.33	0.33	3.00
Standard Dev.	109 €	1.70	1.15	1.49	1.15	1.29	1.46	1.37	0.47	1.63
Evaluations										
<input checked="" type="checkbox"/> PromCalc	0 €	very good	very bad	very bad	average	very bad	very bad	very bad	no	very bad
<input checked="" type="checkbox"/> Decision Lab 2000	0 €	very good	very bad	bad	good	good	very bad	average	no	very bad
<input checked="" type="checkbox"/> D-Sight	249 €	bad	good	very good	bad	average	good	bad	no	average
<input checked="" type="checkbox"/> Smart-Picker Pro	190 €	bad	bad	average	bad	average	average	bad	no	average
<input checked="" type="checkbox"/> Visual PROMETHEE	0 €	very good	average	good	very good	very good	very good	very good	yes	very good
<input checked="" type="checkbox"/> DIY	n/a	very bad	very bad	very good	bad	bad	average	very bad	yes	very good

All \Aoutif/

Actions: 6 (6 active) Criteria: 10 (10 active) Scenarios: 1 (1 active) Saved

Aoutif wants to visually identify the free software from the paid ones so she decides to create two [categories](#) of actions:

- **Free:** this category includes **PromCalc**, **Decision Lab 2000** (as both are discontinued) and **Visual PROMETHEE** (Academic Edition).
- **Paid:** this includes **D-Sight** and **Smart-Picker Pro**.
- The **DIY** solution is different as it involves development time. As such it will be left outside of the two categories.

To define categories:

- Open the [Action Categories](#) dialog using the menu item "**Model | Action Categories...**".
- Click "**New**" to create a new category and enter "**Free**" in the "**Name**" field.
- Choose a shape and a color to identify this category.
- Repeat the procedure for the "**Paid**" category.
- Click "**Close**" to close the dialog.

Now that the categories are created the next step is to assign actions to the categories:

- Click the "**PromCalc**" button to open the [Actions](#) dialog.
- In the **Category** drop-down list select "**Free**".
- Click "**Close**".
- Repeat the procedure for "**Decision Lab 2000**" and for "**Visual PROMETHEE**".
- Notice how the symbol and/or color change for these actions.
- Repeat the procedure for "**D-Sight**" and "**Smart-Picker Pro**" with the "**Paid**" category.

As there are many criteria and some are closely related to each other we are also going to define two groups of criteria:

- **Support:** Support includes **scientific** support (availability of scientific experts to

answer calls) as well as **technical** support (availability of computer scientists to answer technical calls).

- **Function:** Includes **data** management functions (import/export) as well as **analysis** capabilities.

Visual PROMETHEE allows for a three-level [hierarchy](#) of criteria with [groups](#) and [clusters](#). For this case we only need a two-level hierarchy with some criteria grouped together. Here is how you should proceed in such a case:

- Open the [Clusters](#) dialog using the menu item "**Model | Clusters...**".
- Click "**New**" to create a new cluster and enter "**Support**" in the "**Name**" field.
- Choose a shape and a color to identify this cluster.
- Click "**Clone**" to automatically generate a criteria group with the same name.
- Repeat the procedure to create another cluster named "**Function**".
- Click "**Close**" to close the dialog.

Now that the clusters are created the next step is to assign criteria to the clusters:

- Click the "**Scientific**" button to open the [Criteria](#) dialog.
- In the **Group** drop-down list select "**Support**".
- Click "**Close**".
- Repeat the procedure for "**Technical**".
- Notice how the symbol and/or color change for these criteria.
- Repeat the procedure for "**Data**" and "**Analysis**" with the "**Function**" group.

What about preferences? Currently all criteria are set to be maximized. They have equal weights and the preference functions are all set to "**Usual**". Let us proceed now with preference modeling.

○ **The preference parameters**

For each criterion, you have to:

- decide whether it has to be maximized or minimized,
- choose a [preference function](#) and set the values of the corresponding thresholds.

For this problem, it is obvious that **Price** should be minimized: indeed Aouatif prefers to pay less for the software and to save money. The other criteria use qualitative scales that were set up in such a way that they should be maximized. In the **Visual PROMETHEE** spreadsheet change the "**Min/Max**" field for criterion **Price** so that it reads "**min**" instead of "**max**".

The choice of the preference functions is a more difficult step. For qualitative criteria including a small number of evaluation levels the **Usual** preference function is usually a good choice. But for the **Price** criterion small price differences should not be accounted for as much as larger ones. For such a criterion the **Linear** preference function is appropriate. Click on the "**Preference Fn.**" cell for criterion **Price** and change the value from **Usual** to **Linear** in the drop-down list. You now have to change the default values for the indifference (Q) and preference (P) thresholds. Aouatif feels that a 10€ price difference is negligible (she doesn't mind to pay 10€ more) but a 50€ price difference is quite important with respect to the license price range of the software. So Q will be set to 10€ and P to 50€. Change the values accordingly in the spreadsheet (Hint: change P first as **Visual PROMETHEE** won't allow a Q value larger than the current P value).

For the moment we will leave the weights to their initial values (1.00). All criteria thus have the same weight. We will change this later.

The resulting dataset shown in the screenshot below is available as the "**Aouatif Visual PROMETHEE**" file that is installed together with the software.



A first and important step is to verify the quality level of the **GAIA** plane. It is displayed at the bottom right of the [GAIA](#) window. In this case it is equal to 79.2% which is rather good.

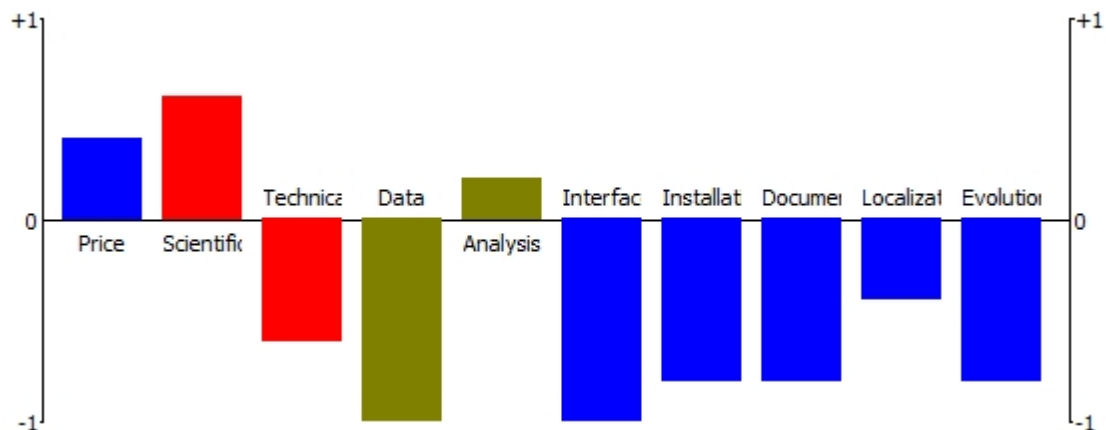
In the **GAIA** plane, the six software are relatively far away from each other with the exception of the two **Paid** software (red diamonds) that are closer to each other. This indicates that most software are quite different from each other. Let us try to explain these differences.

Looking at the criteria, each criterion is represented by an axis. Three groups are detected:

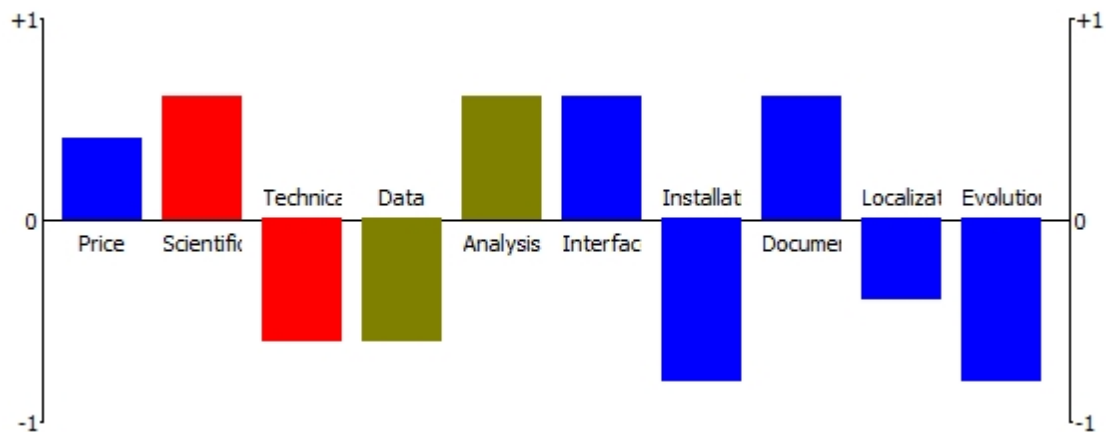
- **Price, Scientific and Analysis:** it is interesting to note that the the **Free** software (green circles) are also the ones with the best **Scientific** support and **Analysis** capabilities.
- **Technical, Data, Installation, Localization and Evolution:** These criteria are oriented towards the right. They separate the older software (on the left side) from the newer (on the right side).
- **Interface and Documentation:** These two criteria are in the middle with respect to the two previous groups. Clearly the best documentation and interface are those of **Visual PROMETHEE**.

Finally we can have a look at the [Action Profiles](#) or [GAIA Webs](#) of the different actions:

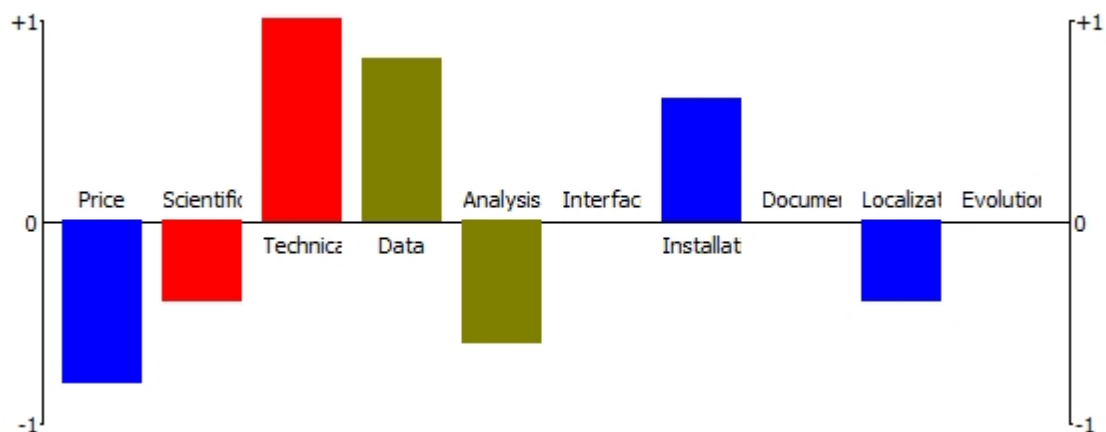
- **PromCalc:** Cheap solution, with a very good scientific background and decent analysis capabilities but very old.



- **Decision Lab 2000:** Better interface and documentation than **PromCalc** but still very old.

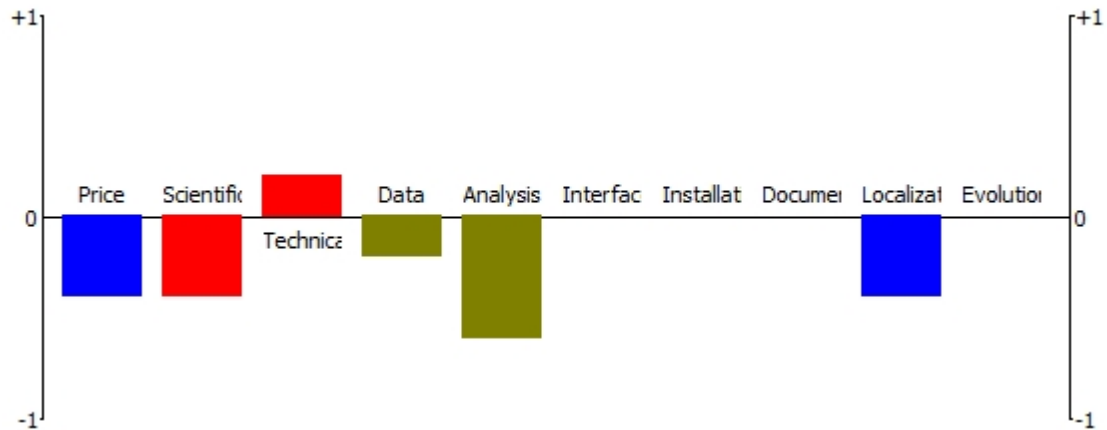


- **D-Sight:** Expensive and not backed by the scientific expertise of the authors of the **PROMETHEE** methods. Technically a good solution (support, data interface and hardware compatibility) even if a bit rough on the interface and weak with respect to documentation. Besides who knows what these guys will do next year?

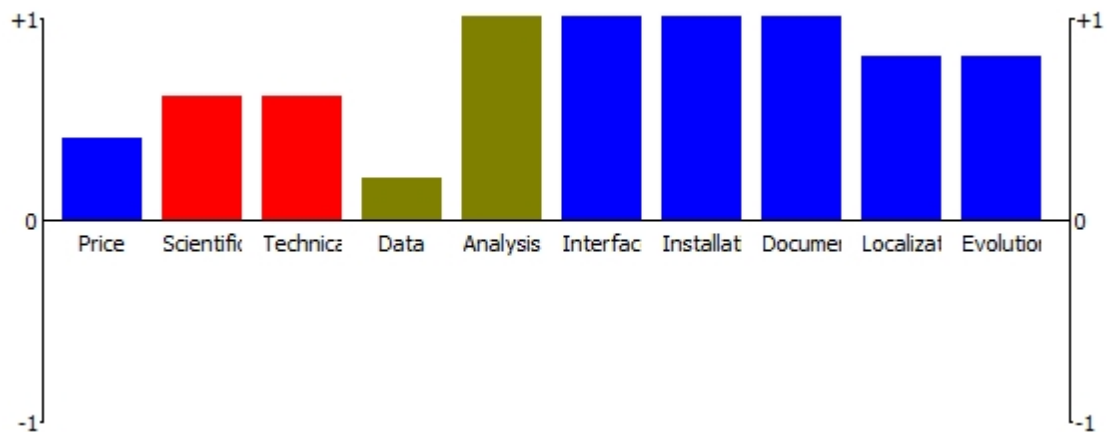


- **Smart-Picker Pro:** Similarly priced and scientifically backed as **D-Sight** it seems more limited with respect to functions. Besides nobody knows who manages the

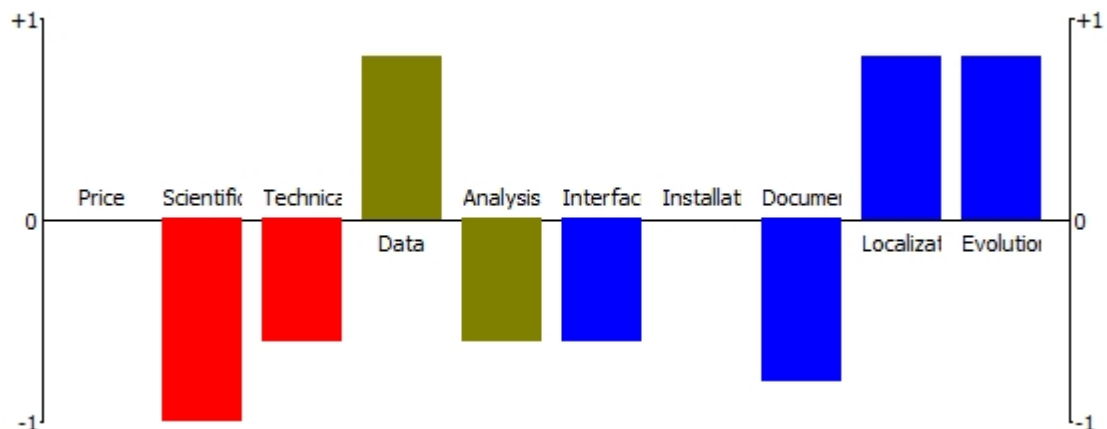
company or where it is located...



- **Visual PROMETHEE:** Backed by the authors of the PROMETHEE methods, this one is the logical evolution of **PromCalc** and **Decision Lab 2000**. The interface is well polished, it includes several new developments, assistants, an extensive documentation, and it can be localized (currently available in five languages). It is also free for non-profit academic purposes.



- **DIY:** The **Do It Yourself** alternative is interesting because it can be tailor-made and it is easy to adapt to future needs. But it is a lot of work and there is no scientific background available to check the results.



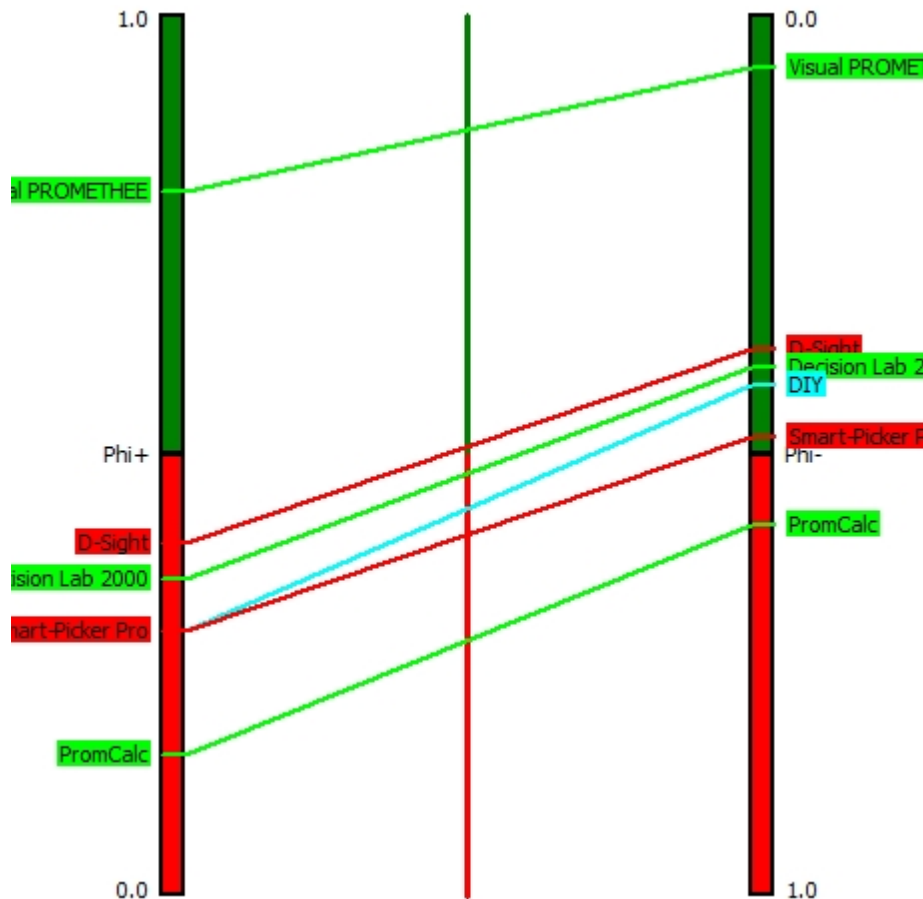
Looking at the position of the decision axis and the orientation of the criteria axes, the current weight distribution seems consistent with the objectives of Aouatif. However a weight sensitivity

analysis could be conducted to check the robustness of the **PROMETHEE** rankings.

○ **PROMETHEE Rankings**

The **PROMETHEE I** ranking shown below is rather clear. Three groups of software appear:

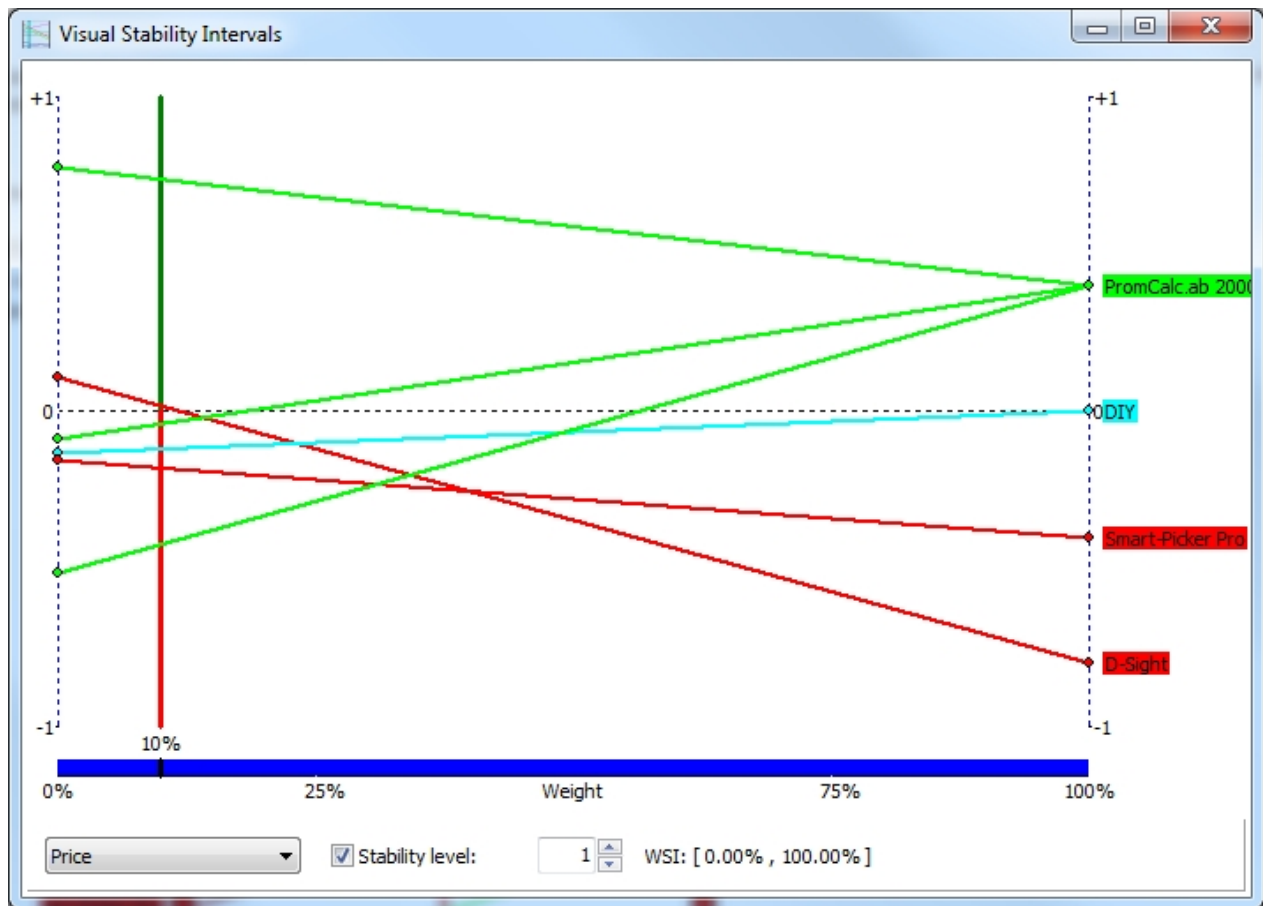
- At the top, **Visual PROMETHEE** dominates the others.
- In the middle, four software are very close to each other. There are no incomparabilities among them.
- At the bottom, **PromCalc** is dominated by all the others.



○ **Sensitivity Analysis**

Let us now check how much the **PROMETHEE** rankings are affected by the weights of the criteria. What if for instance more weight is given to the **Price** criterion?

The [Visual Stability Intervals](#) window can be used for this purpose. The screenshot below shows the display for criterion **Price**. It can be seen that **Visual PROMETHEE** is at the top of the **PROMETHEE II** ranking whatever the weight of the criterion is set to.



You can check that is the same for the following criteria: **Scientific, Analysis, Interface, Installation, Documentation, Localization and Evolution.**

For **Technical**, **Visual PROMETHEE** is the top for weight values less than or equal to 67.86%. For larger weight values, **D-Sight** is first ranked and **Visual PROMETHEE** is second.

For **Data**, the weight has to be larger than 59% to see **D-Sight** and **DIY** at the top of the ranking.

Globally **Visual PROMETHEE** stays at the top of the ranking except for some very uneven weight distributions where most weight is allocated to **Technical** or to **Data**.

4. The conclusion

What do you think?

What software would you be using if you were Aouatif?

How to

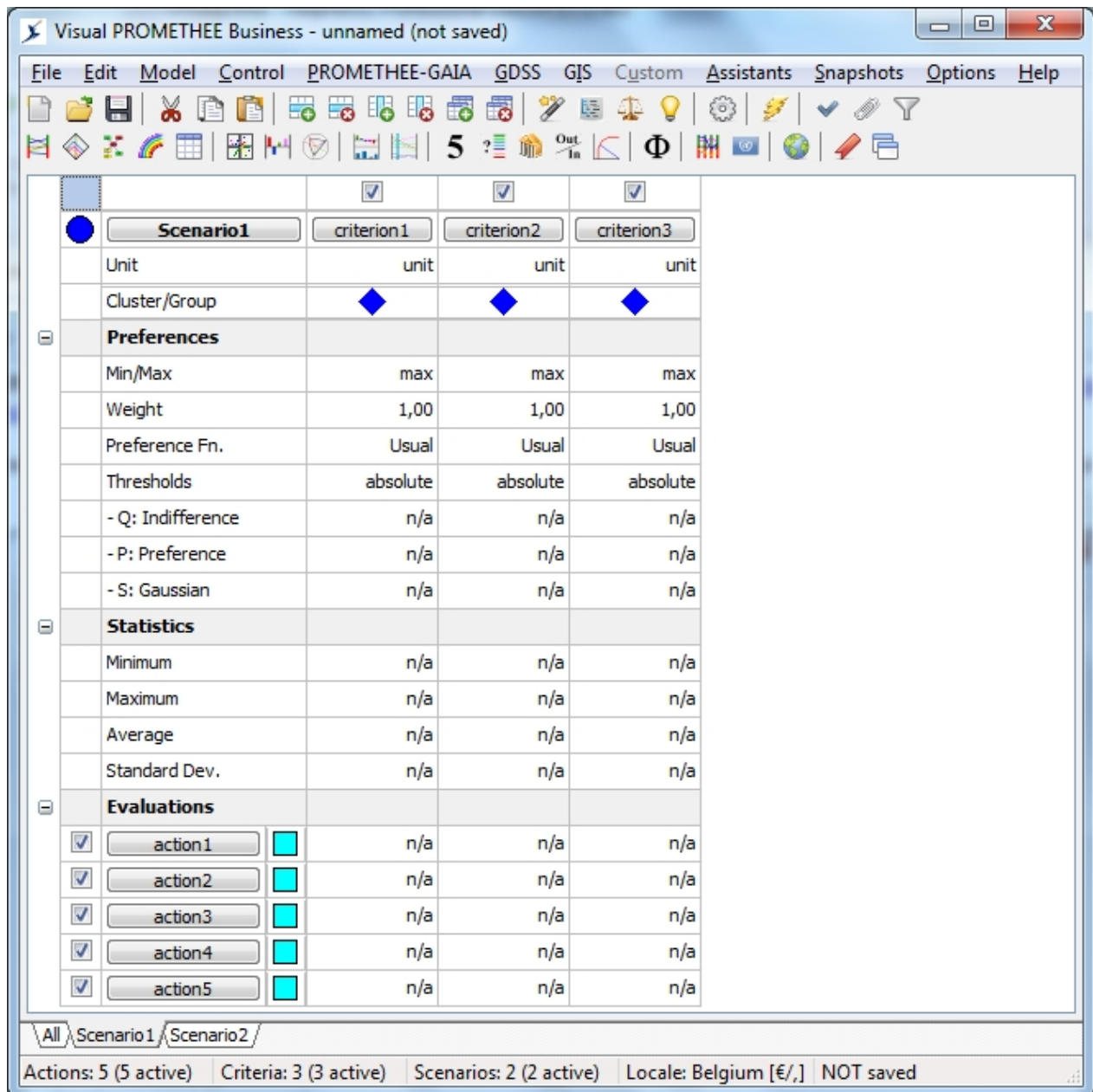
This section contains more detailed explanations about how to manage activities with **Visual PROMETHEE**:

- [Define a new problem](#)
 - [Define the actions](#)
 - [Define the criteria](#)
 - [Define the scenarios](#)
 - [Model preferences](#)
 - [Organize the criteria](#)
 - [Weigh the criteria](#)
- [Rank different actions](#)
- [Use the GAIA analysis](#)
- [Perform a sensitivity analysis](#)
- [Use weight presets](#)
- [Generate a report](#)

Define a new problem

To define a new problem in **Visual PROMETHEE**, first use the "File | New..." command to generate a new empty spreadsheet. The [Create a new problem](#) dialog allows you to specify the number of [actions](#), [criteria](#) and [scenarios](#) that should be included in the new problem. These can be adjusted later if necessary.

The following screenshot shows a newly created problem with five actions, three criteria and two scenarios. As it can be seen default names and data have been automatically generated.



The following steps should then be performed in order to properly model the problem:

1. [Define the actions](#)
2. [Define the criteria](#)
3. [Define the scenarios](#)
4. [Model preferences](#)
5. [Organize the criteria](#)
6. [Weigh the criteria](#)

Define the actions

Click on the name of an action or select "**Model | Actions...**" to open the [Actions](#) dialog and select the [action](#) you want to modify in the **Select** drop-down list. This dialog allows to change the properties of the actions.

The following information should be defined for each action in the decision problem:

- Name: the name of the action.
- Shortname: a shorter name that can be displayed to reduce the clutter on some graphics when there are many actions.
- Active: only active actions are considered in the computation of the results. Uncheck the box if the action should not be considered in the computation.
- Description: a text giving a more detailed description of the action.
- Category: each action belongs to a [category](#) (the default category is named **none**). This is useful to visually identify actions according to specific attributes (geographical location, nationality, technology, ...) as each category can be associated to a specific shape and specific colors. The action category can be selected in the drop-down list. New categories can be created using the "Model | Action Categories..." command (see the [Action Categories](#) dialog).
- Location: For geo-localized data, it is possible to associate a map location to each action. Click on the **Location** button to open the [Location](#) dialog and set the geographical coordinates of the action.

From this dialog you can also add a new action or delete the currently selected one.

Define the criteria

Click on the name of a criterion or select "**Model | Criteria...**" to open the [Criteria](#) dialog and select the [criterion](#) you want to modify in the **Select** drop-down list. This dialog allows to change the properties of the criteria.

The screenshot shows a 'Criterion properties' dialog box with the following fields and values:

- Select: criterion1
- Name: criterion1
- Shortname: C1
- Description: This is criterion criterion1
- Group: none
- Unit: unit
- Scale: numerical
- Decimals: 2
- y/n: y/n

Buttons: New, Close

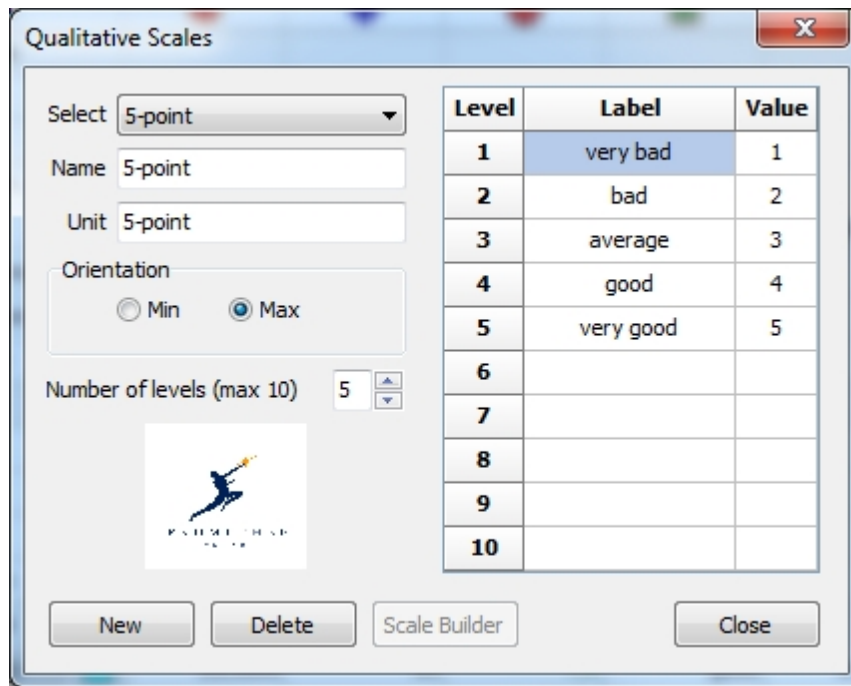
The following information should be defined for each criterion in the decision problem:

- Name: the name of the criterion.
- Shortname: a shorter name that can be displayed to reduce the clutter on some graphics when there are many criteria.
- Active: only active criteria are considered in the computation of the results. Uncheck the box if the criterion should not be considered in the computation.
- Description: a text giving a more detailed description of the criterion.
- Group: each criterion belongs to a [group](#) (the default group is named **none**) and each group belongs to a [cluster](#). This is useful to visually identify criteria that are linked to each other (such as for instance financial, technical, environmental or social criteria) within the Visual PROMETHEE criteria [hierarchy](#) with specific shapes and colors. The criterion group can be selected in the drop-down list. New groups can be created using the "Model | Criteria Groups..." command (see the [Criteria Groups](#) dialog).
- Unit: this is the name of the criterion unit.
- Scale: The drop-down list allows to select one of three possible scale type:
 - numerical: this is for quantitative criteria expressed on a numerical scale, evaluations will be displayed as numbers.
 - currency: this is for money! Evaluations will be displayed as the currency specified in the [localization](#) options,
 - qualitative: qualitative criteria can be evaluated on a [qualitative scale](#), select the name of the scale in the drop-down list below. Qualitative scales can be [defined](#) using the [Qualitative Scales](#) dialog.
- Decimals: the number of decimal places displayed for the criterion.

From this dialog you can also add a new criterion.

Define qualitative scales

To define qualitative scales you can use the "**Model | Qualitative Scales...**" command and open the [Qualitative Scales](#) dialog.



The dialog box titled "Qualitative Scales" contains the following elements:

- Select:** A dropdown menu currently showing "5-point".
- Name:** A text field containing "5-point".
- Unit:** A text field containing "5-point".
- Orientation:** Two radio buttons, "Min" and "Max", with "Max" selected.
- Number of levels (max 10):** A spinner box set to "5".
- Table:** A table with 3 columns: "Level", "Label", and "Value".

Level	Label	Value
1	very bad	1
2	bad	2
3	average	3
4	good	4
5	very good	5
6		
7		
8		
9		
10		
- Buttons:** "New", "Delete", "Scale Builder", and "Close".

From this window you can:

- Select one of the four predefined scales (yes/no, impact, 5-point or 9-point).
- Define a new qualitative scale:
 - Click the "New" button.
 - Give a name and a unit name to the new scale.
 - Set the number of levels (max. 10).
 - Define the levels and the associated values.
 - Define whether the scale values have to be minimized or maximized.

Define the scenarios

Visual PROMETHEE allows to define several [scenarios](#) for a given decision problem.

All the scenarios share:

- The set of actions, and action categories.
- The set of criteria, criteria groups and clusters.
- The qualitative scales.

The scenarios include specific values for:

- The evaluations of the actions.
- The criteria preference structures, including the preference functions and the weights.

Scenarios can be used to represent:

- Several points of view: each scenario corresponds to one stakeholder and incorporates his//her perceptions and preferences.
- Several hypotheses: such as for instance different forecasts for future or expected values.
- Several time periods.
- ...

Click on the name of the current scenario (at the top left of the spreadsheet) or select "**Model | Scenarios...**" to open the [Scenarios](#) dialog and select the [scenario](#) you want to modify in the **Select** drop-down list. This dialog allows to change the properties of the scenarios.

The screenshot shows a 'Scenario properties' dialog box with the following fields and values:

- Select:** Scenario1 (dropdown menu)
- Name:** Scenario1 (text input)
- Shortname:** S1 (text input)
- Active:** ☒ (checkbox)
- Description:** This is Scenario1 (text area)
- Weight:** 1 (text input)
- Coalition:** none (dropdown menu)

At the bottom of the dialog are three buttons: 'New', 'Delete', and 'Close'.

The following information should be defined for each scenario in the decision problem:

- Name: the name of the scenario.
- Shortname: a shorter name that can be displayed to reduce the clutter on some graphics when there are many scenarios.
- Active: only active scenarios are considered in the computation of the results. Uncheck the box if the scenario should not be considered in the computation.
- Description: a text giving a more detailed description of the scenario.
- Weight: relative weight of the scenario.
- Coalition: the [coalition](#) to which the scenario belongs.

From this dialog you can also add a new scenario or delete the currently selected one.

New scenarios can be added by:

- Clicking on the **New** button in the [Scenarios](#) dialog.
- Clicking the "Add scenario" button in the main window [toolbar](#).
- Selecting "Edit | Duplicate Scenario" in the [Main Menu](#) to duplicate the current scenario.

Model preferences

Once the set of [actions](#) and the set of [criteria](#) have been defined it is important to model preferences.

This is done in two steps with **Visual PROMETHEE**:

1. A [preference function](#) has to be associated to each criterion.
2. The criteria have to be [weighed](#) according to the [decision-maker](#) priorities.

This has to be done separately for each [scenario](#).

Preference functions

Six different types of [preference function](#) are available in **Visual PROMETHEE**.

Use the [Preference Function Assistant](#) to get advice on the best choice.

Weights

[Weights](#) have to be allocated to the criteria in order to reflect their relative importance for the decision maker.

When the number of criteria is large, it can be more difficult to allocate the weights. In such cases however criteria can often be [organized hierarchically](#) into [clusters](#) and [groups](#). This makes it easier to allocate the weights and to ensure that no bias is induced by the number of criteria.

Use the [Weighing Assistant](#) to help you allocating weights.

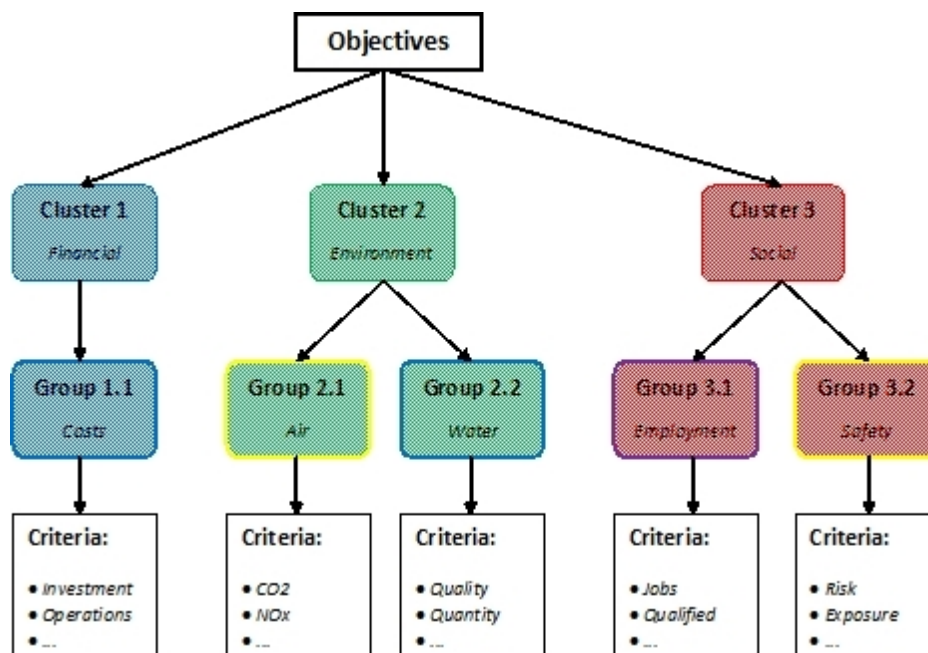
Organize the criteria

Visual PROMETHEE allows to organize criteria into a three-level hierarchy. This is especially useful when the number of criteria is large. In such cases criteria can usually be grouped according to higher level objectives.

For instance in a context of sustainable development three higher objectives can be identified:

- Financial: criteria that measure the financial impact of the decisions.
- Environment: criteria that measure the environmental impacts of the decisions.
- Social: criteria that measure the social impacts of the decisions.

In **Visual PROMETHEE** these can be associated to [clusters](#) of criteria. This is the higher level of the hierarchy.



Within each cluster, several sub-groups of criteria can often be defined. For instance in the Environment cluster of criteria, the following [criteria groups](#) could be defined:

- Air: environmental impacts linked to the air quality.
- Water: environmental impacts linked to the water quality or availability.

This is the intermediate level of the hierarchy.

At the bottom level are the individual criteria:

- Each individual criterion belongs to one group.
- Each group belongs to one cluster.

In **Visual PROMETHEE** clusters and criteria groups are identified by colors:

- Each cluster is identified by a shape and background color.
- Each criteria group is identified by an outline color.

Clusters and criteria groups can also be analyzed as a whole using their **Grouped** property. This makes sensitivity analyses much easier.

The [Weighing Assistant](#) allows to allocate hierarchically the weights to the criteria.

Weigh the criteria

[Weights](#) have to be allocated to the criteria in order to reflect their relative importance for the decision maker.

Use the [Weighing Assistant](#) to help you allocating weights.

Rank different actions

Once the [actions](#) and [criteria](#) have been [defined](#) and the preference parameters (preference functions and weights) have been [set](#), it is possible to rank the actions using the **PROMETHEE** method.

PROMETHEE Rankings

Click "**PROMETHEE-GAIA | PROMETHEE Rankings**" to open the **PROMETHEE Rankings** window.

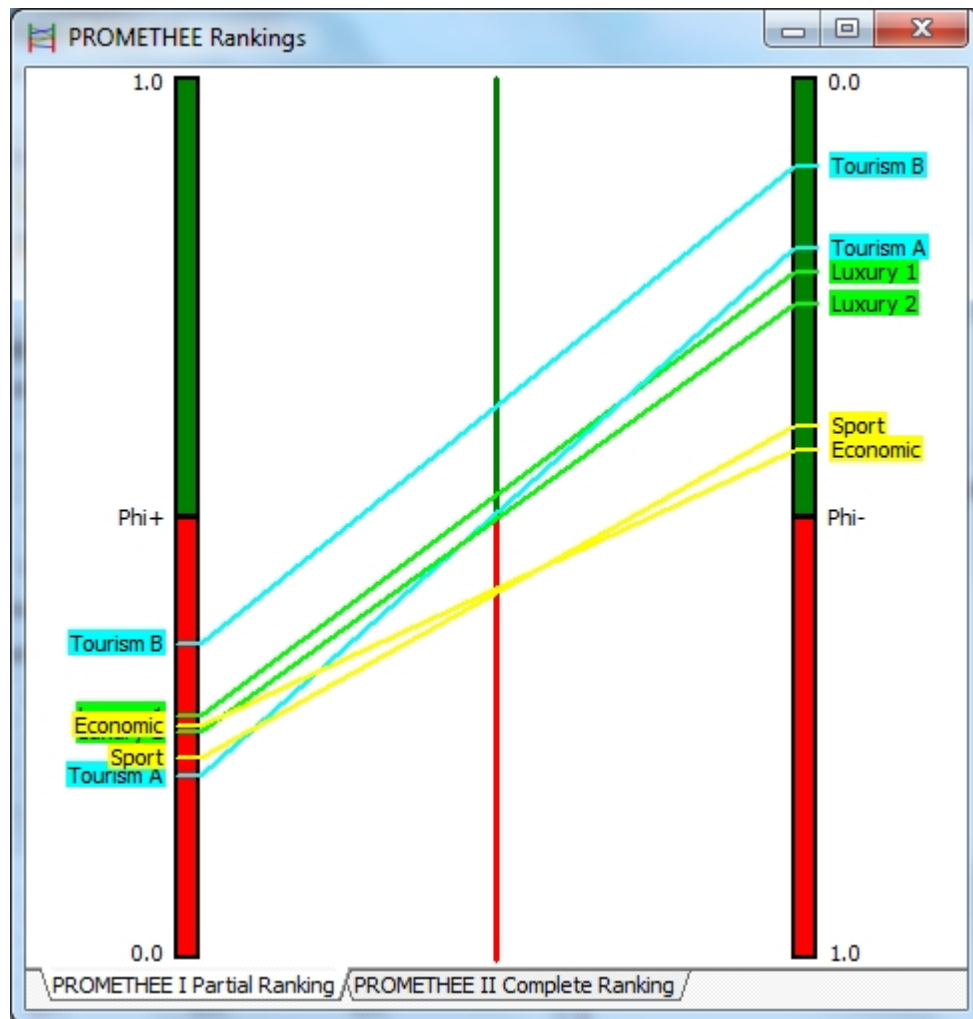
There are two tabs at the bottom of the window:

- [PROMETHEE I Partial Ranking](#)
- [PROMETHEE II Complete Ranking](#)

PROMETHEE I Partial Ranking

The [PROMETHEE I Partial Ranking](#) is based on the computation of two [preference flows](#):

- **Phi+** (positive or leaving flow) is a measure of strength. It is represented on the left-side bar with the best (largest) values in green at the top of the bar and the worst in red at the bottom.
- **Phi-** (negative or entering flow) is a measure of weakness. It is represented on the right-side bar with the best (smallest) values in green at the top of the bar and the worst in red at the bottom.



Both **Phi+** and **Phi-** can be used to rank the actions. However they don't always provide exactly the same ranking. Indeed because of the conflicting aspect of a multicriteria problem it is not always easy to compare two actions: one can be much better on one subset of criteria and the other can be much better on another subset of criteria. In such cases and according to the preference parameters defined by the decision-maker different ways of evaluation (such as **Phi+** and **Phi-**) can lead to different rankings.

PROMETHEE I tries to be prudent in such cases: it compares the two rankings induced by **Phi+** and **Phi-** and only includes preferences that are confirmed by both rankings. Consequently it is only a partial ranking: when the two flow rankings conflict with each other no comparison is made ([incomparability](#)). This can be useful as it shows the decision-maker what are the most difficult comparisons.

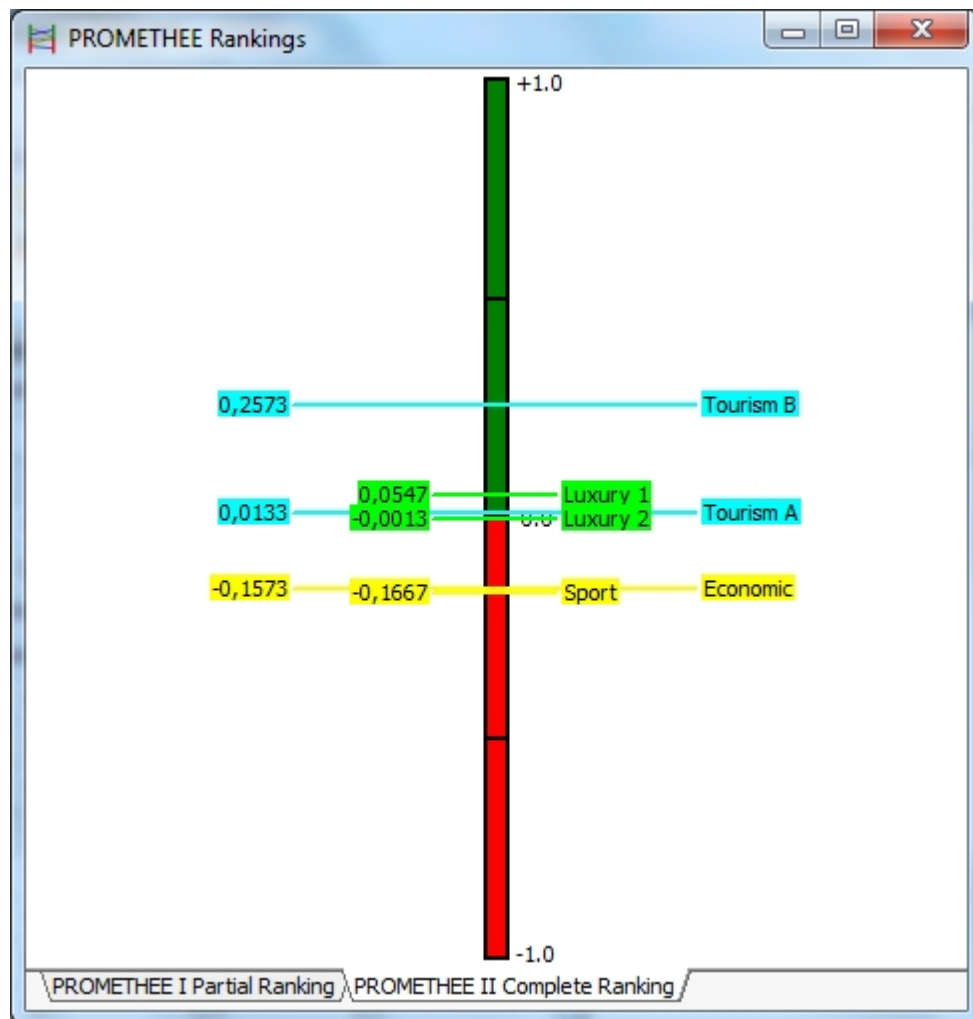
In **Visual PROMETHEE** the **PROMETHEE I** partial ranking is displayed by drawing a line for each action between its **Phi+** score on the left vertical bar and its **Phi-** score on the right vertical bar. When a line is on top of another it means that the action is preferred to the other. When two lines are crossing each other it means that the actions are incomparable in **PROMETHEE I**.

In the above example we see that **Tourism B** is preferred to all the other actions. The **Sport** car is incomparable with the **Economic** one. And **Tourism B** is incomparable with all the other actions (except **Tourism B**).

The way the display is organized the middle vertical bar actually shows to the **Phi** net flow scores of the actions and thus displays the **PROMETHEE II** Complete Ranking that is discussed in the next section.

PROMETHEE II Complete Ranking

The [PROMETHEE II Complete Ranking](#) is based on the **Phi** net flow which is the balance (difference) between **Phi+** and **Phi-**. The **Phi** score can be negative: it is a number in the -1 to +1 range. The **PROMETHEE Rankings** window displays the **Phi** scores on a vertical bar.



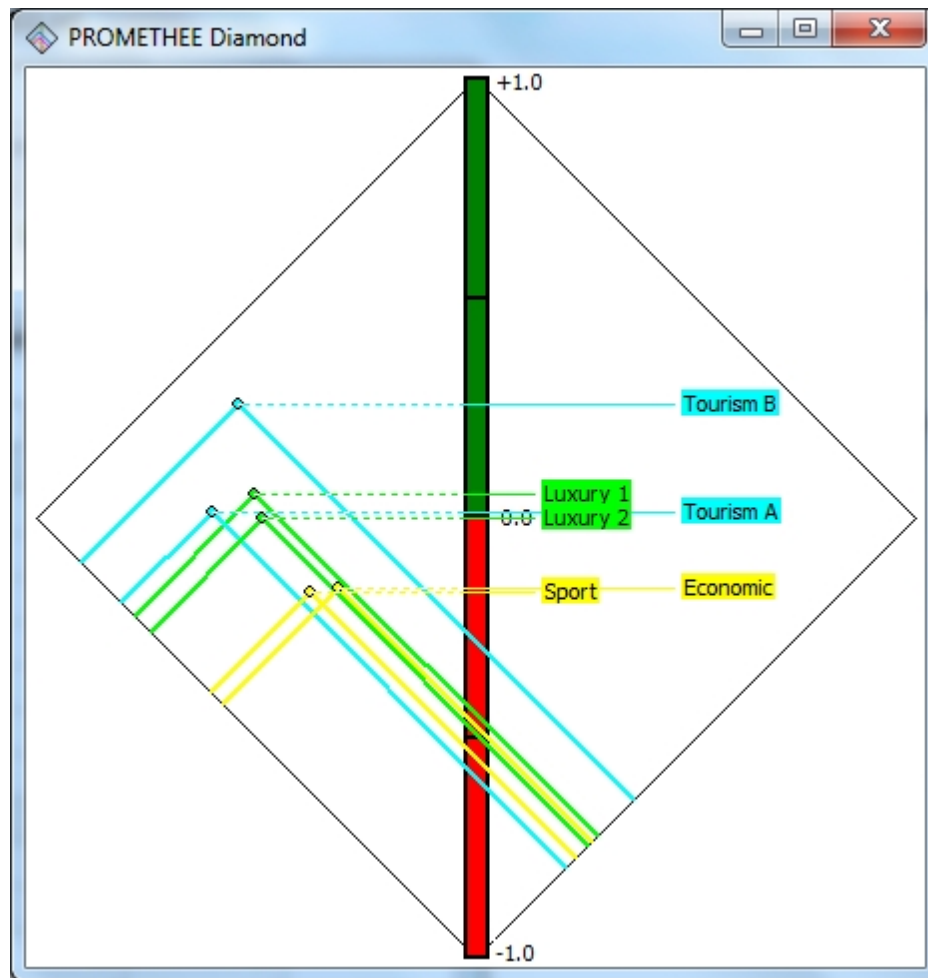
In the above example, three groups of actions are easily identified:

- **Tourism B** at the top.
- **Luxury 1**, **Luxury 2** and **Tourism A** in the middle.
- **Sport** and **Economic** at the bottom.

It should be noted that as the **PROMETHEE II** Complete Ranking doesn't include any incomparabilities it is thus less prudent than the **PROMETHEE I** Partial Ranking.

PROMETHEE Diamond

The [PROMETHEE Diamond](#) is an alternate view of the **PROMETHEE** Rankings.



The 45°-angled square corresponds to the (Φ^+, Φ^-) plane oriented in such a way that the vertical axis gives the Φ score.

Each action is represented by a cone. The top of the cone is located at the (Φ^+, Φ^-) coordinates of the action.

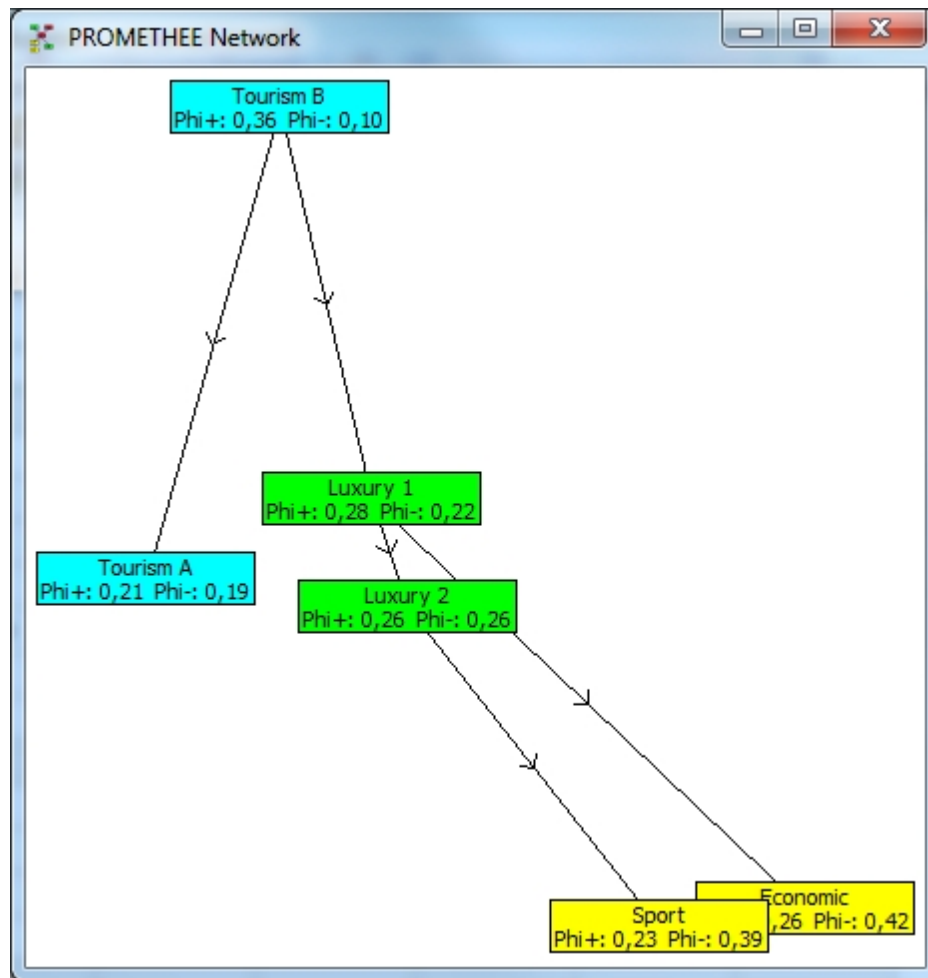
When a cone overlaps another one it corresponds to a preference. When two cones intersect each other there is an incomparability in the **PROMETHEE II** Partial Ranking.

In this example the three groups of actions are very easy to distinguish from each other.

PROMETHEE Network

Click "**PROMETHEE-GAIA | PROMETHEE Network**" to open this window.

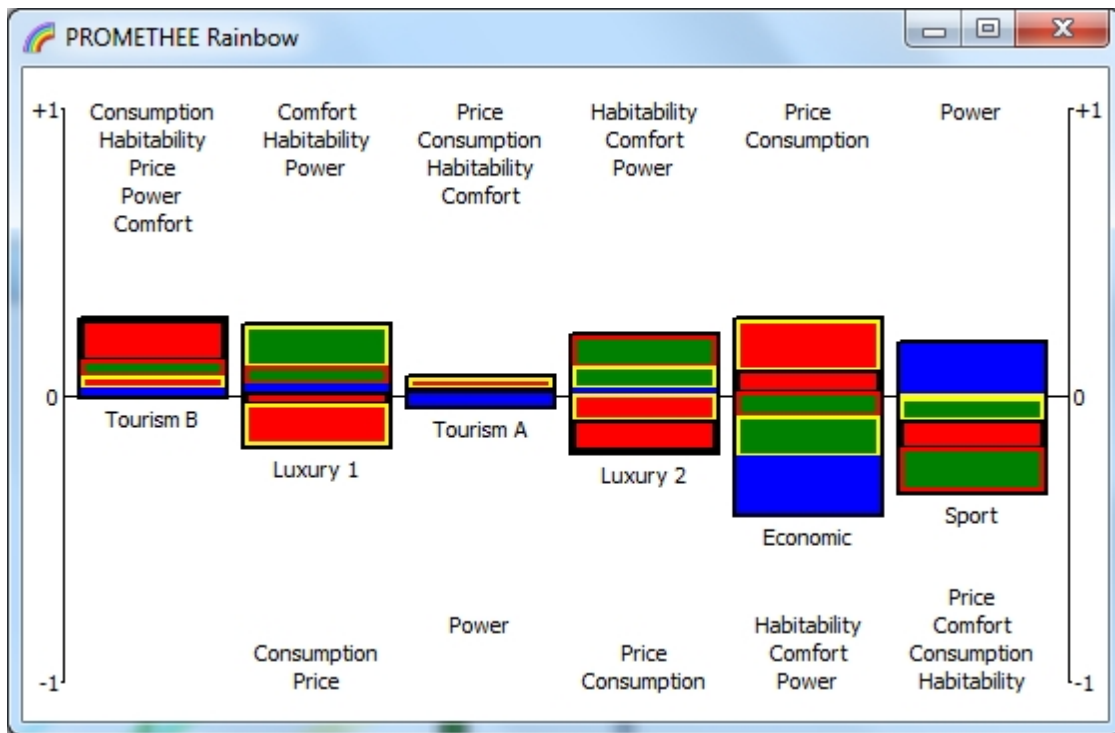
The [PROMETHEE Network](#) representation of the **PROMETHEE I** Partial Ranking will feel familiar to the users of older **PROMETHEE** software such as **PromCalc** or **Decision Lab**. Actions are represented by nodes and arrows are drawn to indicate preferences. Incomparabilities are thus very easy to detect.



Visual PROMETHEE uses an enhanced network representation: instead of drawing the nodes at arbitrary locations the relative positions of the actions in the **PROMETHEE Diamond** are used. The network representation is like a close-up of the **Diamond** view where preferences are indicated by arrows. This makes it very straightforward to appreciate the proximity between actions and thus the degrees of incomparability in the partial ranking.

PROMETHEE Rainbow

The [PROMETHEE Rainbow](#) is a disaggregated view of the **PROMETHEE II** Complete Ranking.



For each action a bar is drawn with as many slices as the number of criteria. Each slice corresponds to the contribution of the criterion to the **Phi** net flow score of the action taking into account the weight of the criterion. This way the sum of the positive slices minus the sum of the negative ones is equal to the **Phi** net flow score of the action.

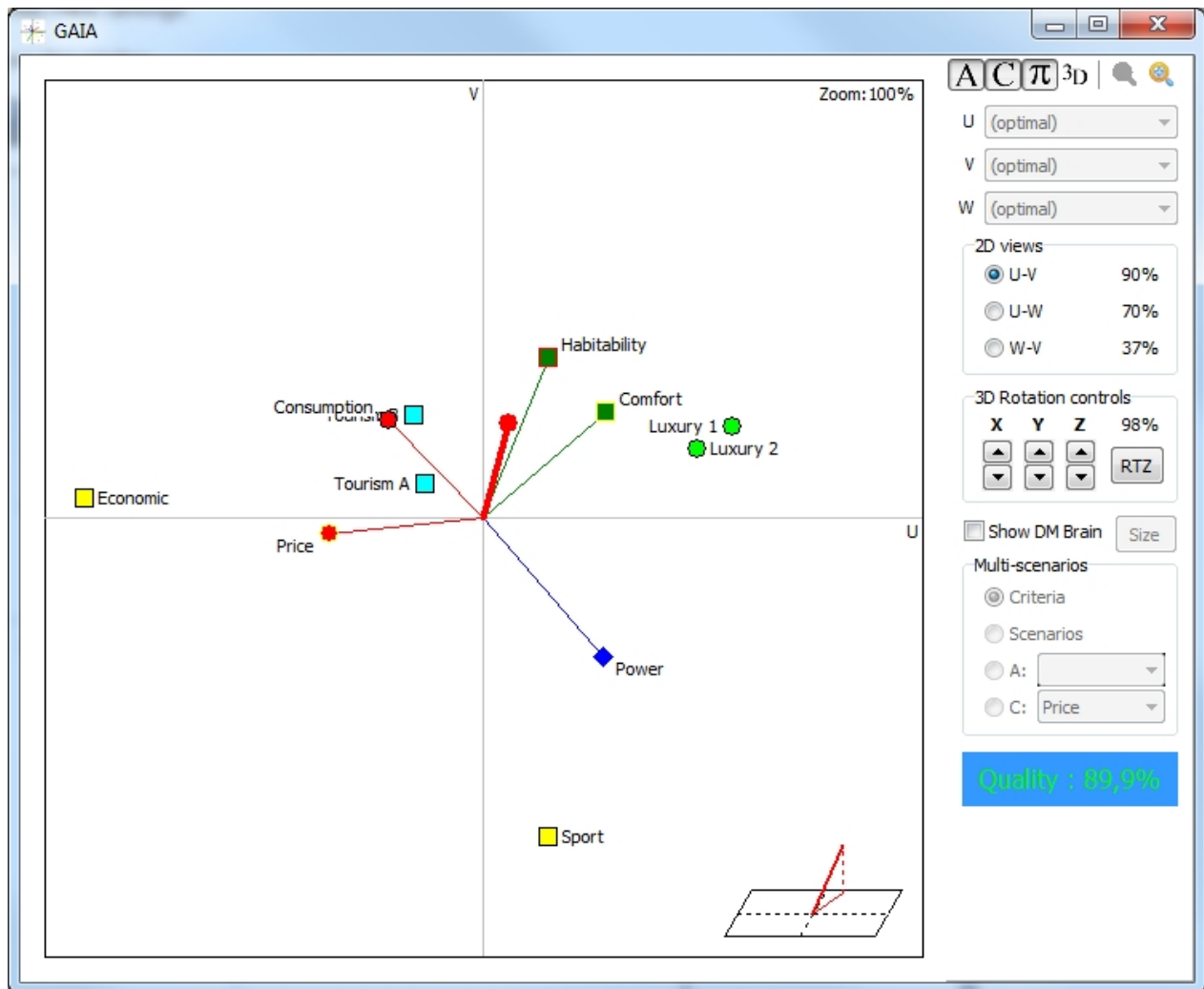
In the above example it appears that:

- **Tourism B** has no negative contributions to its **Phi** score. It has no weaknesses compared to the other actions.
- While **Luxury 1**, **Tourism A** and **Luxury 2** have **Phi** scores that are very close to each other, the **Tourism A** car appears to be quite different from the two other ones: its bar is very short which means that it has a very average profile. The two other cars have larger bars with positive and negative slices: they are better on some criteria and worse on others.
- The **Economic** car has a very large bar: it is very good on some criteria (**Price** and **Consumption**) and very bad on others (**Habitability**, **Comfort** and **Power**).

Use the GAIA analysis

The [GAIA](#) analysis is a descriptive complement to the **PROMETHEE** rankings.

Click "**PROMETHEE-GAIA | GAIA Visual Analysis**" to open the [GAIA](#) window.



Detailed information about using **GAIA** can be found [here](#).

Perform a sensitivity analysis

It is important to keep mind that decision aid models such as the one used in the **PROMETHEE** and **GAIA** methods rely on different assumptions that make it possible to analyze the [decision problem](#) and to provide the [decision-maker](#) with sound advice.

In particular the **PROMETHEE** methodology rely on the definition of [preference functions](#) and [weights](#) to model the preferences and priorities of the decision-maker.

Visual PROMETHEE has been conceived to make this important modeling step as easy as possible:

- Most important data are centralized and can be modified directly in a spreadsheet-like table in the [main window](#).
- The [Preference Function Assistant](#) is available to guide the choice of the preference functions.
- The [Weighing Assistant](#) and the [Criteria Hierarchy Assistant](#) can be used to organize the criteria and to allocate the weights.

While empirical studies have shown that the **PROMETHEE** method is rather robust with respect to the values of the preference function thresholds, the weights of the criteria usually have a strong impact on the results of the analysis, especially when there are strongly conflicting criteria.

Performing a weight sensitivity analysis is thus essential and **Visual PROMETHEE** includes several tools to facilitate this type of sensitivity analyses:

- [Actions](#), [categories](#), [criteria](#), [groups](#), [clusters](#), [scenarios](#) and [coalitions](#) can be temporarily deactivated using the [Activation Center](#) window to test or to compare easily different model configurations. Actions and Criteria can even be deactivated directly from the main window using intuitive checkboxes.
- The [Walking Weights](#) window can be used to interactively modify the weights. All the computations are continuously adjusted and the contents of the opened windows are updated as well.
- The [Visual Stability Intervals](#) window provides the user with a more exhaustive weight sensitivity analysis: it shows how the **Phi** score and the **PROMETHEE II** ranking vary as a function of the weight of a criterion and identifies the interval of stability of the top ranked actions.
- The [Decision Maker Brain](#) visualization in the [GAIA](#) window shows the degree of difficulty of the decision problem according to the robustness of the **PROMETHEE II** ranking to weight variations.
- The possibility to define multiple scenarios for a same decision problem can be used to compare different points of view in a group decision context ([GDSS](#)). It can also be useful to compare different hypotheses, for instance when the evaluation of some criteria relies on forecasts or is imprecise.
- The [Balance of Power](#) window is similar to the **Walking Weights** but allows for changing the weights of the scenarios.

Use weight presets

[Weight Presets](#) allow you to save up to five different sets of weights for easy comparison.

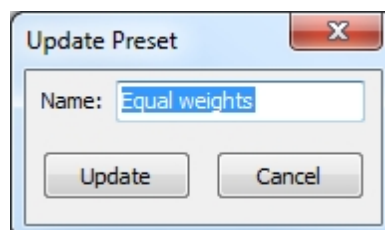
Indeed the [weights](#) allocated to the [criteria](#) are critical preference parameters: different weights can lead to quite different rankings especially when the criteria are conflicting.

Use the "Snapshots | Weight Presets" menu to open the **Weight Presets** window.



The window has two columns of buttons:

- The left column is used to switch from one weight preset to another. Just click the button to switch to a previously defined preset.
- The right column ("Update" buttons) is used to store presets: click on the "Update" button to store the current weights in the corresponding preset, a dialog opens to let you change the name of the preset and confirm:



Click "Update" to save the preset with the current weights or click "Cancel" to cancel the change.

The **Weight Presets** are saved together with the problem data so that you can restore them later.

Generate a report

The data and the results of the analysis can be exported from **Visual PROMETHEE** in different ways to support reporting:

- Most windows include a [local menu](#) with a "**Copy**" item that can be used to copy the window's content to the clipboard. Most graphical output can thus be pasted directly into other applications such as word processors or presentation software.
- The "**File | Export...**" menu item can be used to [export](#) data and numerical results to a text file that can be imported in a spreadsheet software.
- The [Report Generator](#) ("**File | Report...**") produces a tailor-made report with multiple user-selectable sections. Reports can be generated in **HTML**, **PDF** or **XLS(X)** format.

User Interface

Visual PROMETHEE has a standard MS-Windows interface. Most controls are centralized in the main window (main menu and toolbars) and in local menus that are available in most windows:

- [Main Menu](#)
- [Toolbars](#)
- [Local Menus](#)

Main Menu

The **Visual PROMETHEE** Main Menu is organized as follows:

	Price	Power	Consumption	Habitability	Comfort
Unit	k€	kW	L/100km	5-point	5-point
Cluster/Group					
Preferences					
Min/Max	min	max	min	max	max
Weight	1,00	1,00	1,00	1,00	1,00
Preference Fn.	V-shape	Linear	V-shape	Level	Level
Thresholds	absolute	absolute	absolute	absolute	absolute
- Q: Indifference	n/a	5	n/a	1,0	0,5
- P: Preference	€ 15,000	30	2,0	2,5	2,5
- S: Gaussian	n/a	n/a	n/a	n/a	n/a
Statistics					
Minimum	€ 15,000	50	7,0	1,0	1,0
Maximum	€ 38,000	110	9,0	5,0	5,0
Average	€ 28,083	83	8,2	3,2	3,0
Standard Dev.	€ 7,407	18	0,7	1,3	1,3
Evaluations					
<input checked="" type="checkbox"/> Tourism B	€ 25,500	85	7,0	good	average
<input checked="" type="checkbox"/> Luxury 1	€ 38,000	90	8,5	good	very good
<input checked="" type="checkbox"/> Tourism A	€ 26,000	75	8,0	average	average
<input checked="" type="checkbox"/> Luxury 2	€ 35,000	85	9,0	very good	good
<input checked="" type="checkbox"/> Economic	€ 15,000	50	7,5	bad	very bad
<input checked="" type="checkbox"/> Sport	€ 29,000	110	9,0	very bad	bad

Actions: 6 (6 active) Criteria: 5 (5 active) Scenarios: 1 (1 active) Locale: Belgium [€/€] Saved

- [File](#)
 - [New](#)

To start entering the data for a new problem. This opens the [New](#) dialog.

- **Problem Creation Assistant**
This launches the [Problem Creation Assistant](#).
 - **Open**
To open an existing Visual PROMETHEE file.
 - **Recent files**
Opens a sub-menu with the names of the five last opened files. Click on a file name to open the file.
 - **Save**
To save the current problem under its existing file name.
 - **Save As**
To save the current problem under a new file name.
 - **Import**
To import data from various formats of text files.
 - **Export**
To export data and results to a text file.
 - **Report**
To generate an HTML report.
 - **PROMETHEE Certificate**
To manage the PROMETHEE Certification of your files (this is **NOT** available in the current version).
 - **Exit**
To exit Visual PROMETHEE.
- **Edit**
This is a standard Edit menu.
 - **Cut**
 - **Copy**
 - **Paste**
 - **Select All**
 - **Duplicate action**
To create a new action which is a copy of the currently selected action.
 - **Duplicate criterion**
To create a new criterion which is a copy of the currently selected criterion.
 - **Duplicate scenario**
To create a new scenario which is a copy of the current scenario.
- **Model**
This is the menu that gives access to the different components of the current problem. From here you can edit most data.
 - **Info**
General information related to the current problem.
 - **Qualitative Scales**
Definition and management of the qualitative scales.
 - **Actions**
Definition and management of the actions.
 - **Criteria**
Definition and management of the criteria.
 - **Scenarios**
Definition and management of the scenarios.
 - **Classes**
Definition and management of the classes for sorting actions.
 - **Hierarchy Assistant**
Launches the [Hierarchy Assistant](#).
 - **Weighing Assistant**
Launches the [Weighing Assistant](#).
 - **Action Categories**

- Definition and management of the action categories.
- [Criteria Groups](#)
Definition and management of the criteria groups.
- [Clusters](#)
Definition and management of the clusters.
- [Coalitions](#)
Definition and management of the coalitions.
- **Control**
 - [Activate](#)
Opens the activity center.
 - [Group](#)
Opens the grouping window.
 - [Filter](#)
Allows to filter (deactivate) actions according to criteria values.
 - [Sort](#)
Allows to sort actions, criteria and other items according to various criteria.
 - [Close all windows](#)
Closes all opened windows.
- **PROMETHEE-GAIA**
This is the menu from where most analysis results can be accessed.
 - [PROMETHEE Rankings](#)
Separate visual representations of the **PROMETHEE I** Partial Ranking (line chart) and **PROMETHEE II** Complete Ranking ("thermometer").
 - [PROMETHEE Diamond](#)
Combined visual representations of the **PROMETHEE I** and **II** Rankings.
 - [PROMETHEE Network](#)
Network representation of the **PROMETHEE I** Partial Ranking.
 - [PROMETHEE Rainbow](#)
Disaggregated view of the **PROMETHEE II** Complete Ranking.
 - [PROMETHEE Table](#)
Multicriteria leaving (Phi+), entering (Phi-) and net (Phi) flow values.
 - [GAIA Visual Analysis](#)
GAIA 2D and 3D displays.
 - [Action Profiles](#)
Up to five separate profile windows can be opened to compare the profiles of individual actions.
 - [GAIA Webs](#)
Up to five separate **GAIA** Web windows can be opened to compare the profiles of individual actions.
 - [Walking Weights](#)
Visual weight sensitivity analysis.
 - [Visual Stability Intervals](#)
Visual weight stability analysis.
 - [PROMETHEE V Selection](#)
Opens the [PROMETHEE V](#) window.
 - [PROMETHEE Sort](#)
Opens the [PROMETHEE Sort](#) window.
 - [Bank Adviser](#)
Reference set-based evaluation.
 - [Performance Analysis](#)
Opens the [Performance Analysis](#) sub-menu.
 - [Preference Flows](#)
Opens a window displaying the unicriterion net flow scores as well as the multicriteria flow scores.

- **GDSS**
This is a specialized menu for Group Decision Support System (GDSS) features of **Visual PROMETHEE**.
 - [Scenarios Comparison](#)
Side-by-side comparison of the scenarios net flow scores.
 - [Balance of Power](#)
Allocate weights to the different scenarios.
- **GIS**
This is a specialized menu for Geographical Information System (GIS) features of **Visual PROMETHEE**.
 - [PROMap](#)
Integrate **PROMETHEE-GAIA** analyses with Google Maps.
- **Custom**
This is the menu where the custom functions available in specialized versions of **Visual PROMETHEE** are located.
- **Assistants**
 - [Create](#)
This assistant helps you step by step to setup a new decision problem from scratch.
 - [Hierarchize](#)
This assistant helps you to organize the criteria in the **Visual PROMETHEE** three-level hierarchy.
 - [Weigh](#)
This assistant helps you to allocate weights to the criteria within the three-level hierarchy.
 - [Analyze](#)
This assistant helps you to better understand the results of the **PROMETHEE-GAIA** analysis.
- **Snapshots**
 - [Weight Presets](#)
Allows you to save up to five different weight distributions for easy comparison.
 - [Layouts](#)
Allows you to save up to five different windows layout for different types of analyses.
- [Options](#)
- **Help**
 - [Help](#)
Opens the help/manual.
 - www.promethee-gaia.net
Direct access to the **PROMETHEE-GAIA** web site (Internet connection required).
 - [The PROMETHEE Blog](#)
Direct access to the **PROMETHEE Blog** web site (Internet connection required).
 - [The PROMETHEE FAQ](#)
Direct access to the **PROMETHEE FAQ** web site (Internet connection required).
 - [Register...](#)
Registration of the [Demo](#) to the [Business Edition](#).
 - [About](#)
Opens the "About" window where software version information can be found.






Toolbars

There are two toolbars in the main **Visual PROMETHEE** window.

Visual PROMETHEE Business - unnamed (saved)

File Edit Model Control PROMETHEE-GAIA GDSS GIS Custom Assistants Snapshots Options Help

Unit: k€, kW, L/100km, 5-point, 5-point

Cluster/Group:     







Preferences

	Price	Power	Consumption	Habitability	Comfort
Min/Max	min	max	min	max	max
Weight	1,00	1,00	1,00	1,00	1,00
Preference Fn.	V-shape	Linear	V-shape	Level	Level
Thresholds	absolute	absolute	absolute	absolute	absolute
- Q: Indifference	n/a	5	n/a	1,0	0,5
- P: Preference	€ 15,000	30	2,0	2,5	2,5
- S: Gaussian	n/a	n/a	n/a	n/a	n/a

Statistics

	Price	Power	Consumption	Habitability	Comfort
Minimum	€ 15,000	50	7,0	1,0	1,0
Maximum	€ 38,000	110	9,0	5,0	5,0
Average	€ 28,083	83	8,2	3,2	3,0
Standard Dev.	€ 7,407	18	0,7	1,3	1,3


Evaluations










	Price	Power	Consumption	Habitability	Comfort
<input checked="" type="checkbox"/> Tourism B 	€ 25,500	85	7,0	good	average
<input checked="" type="checkbox"/> Luxury 1 	€ 38,000	90	8,5	good	very good
<input checked="" type="checkbox"/> Tourism A 	€ 26,000	75	8,0	average	average
<input checked="" type="checkbox"/> Luxury 2 	€ 35,000	85	9,0	very good	good
<input checked="" type="checkbox"/> Economic 	€ 15,000	50	7,5	bad	very bad
<input checked="" type="checkbox"/> Sport 	€ 29,000	110	9,0	very bad	bad

All Bertrand






















Actions: 6 (6 active) Criteria: 5 (5 active) Scenarios: 1 (1 active) Locale: Belgium [€/€] Saved

The **top row toolbar** includes typical management options:

- New: Start a new problem.
- Open: Open an existing data file.
-  Save: Save the current data.
- Cut: Cut to Clipboard.
- Copy: Copy to Clipboard.
- Paste: Paste from Clipboard.
- Add action: Add a new action to the current problem.
- Delete action: Delete the current action.
- Add criterion: Add a new criterion to the current problem.
- Delete criterion: Delete the current criterion.
- Add scenario: Add a new scenario to the current problem.
- Delete scenario: Delete the current scenario.

-  [Creation Assistant](#): Launch the Problem Creation Assistant.
-  [Hierarchy Assistant](#): Launch the Criteria Hierarchy Assistant
-  [Weighing Assistant](#): Launch the Criteria Weighing Assistant
-  [Analysis Assistant](#): Launch the Problem Analysis Assistant
-  [Options](#): Options.
-  Force Recalc: Launch full computation update.
-  Activation Center: Control the activity level of actions, criteria and scenarios.
-  Grouping: Control the grouping of criteria and scenarios.
-  Filter: Filter actions according to criteria values.

The **bottom row toolbar** includes most analysis options:

-  [PROMETHEE Rankings](#)
-  [PROMETHEE Diamond](#)
-  [PROMETHEE Network](#)
-  [PROMETHEE Rainbow](#)
-  [PROMETHEE Table](#)
-  [GAIA](#)
-  [Action Profiles](#)
-  [GAIA Webs](#)
-  [Walking Weights](#)
-  [Visual Stability Intervals](#)
-  [PROMETHEE V Selection](#)
-  [PROMETHEE Sort](#)
-  [Bank Adviser](#)
-  [Performance Analysis](#)
-  [Efficient Frontier](#)
-  [Preference Flows](#)
-  [Scenario Comparison](#)
-  [Balance of Power](#)
-  [PROMap](#)
-  [Weight Presets](#)
-  [Layouts](#)

Local Menus

Local menus are available in most **Visual PROMETHEE** windows.

The local menus usually include:

- Options to control the current display.
- Copy to clipboard function.

Right-click on the window to open the local menu.

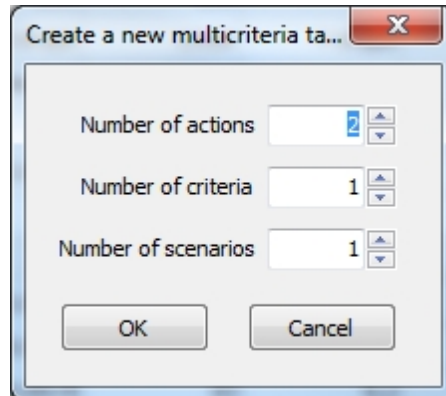
Dialogs

Here is a list of all the dialogs available in **Visual PROMETHEE**.

- [New](#)
- [Import data](#)
- [Export data](#)
- [Report generator](#)
- [PROMETHEE Certificate](#)
- [Model](#)
 - [Problem Info](#)
 - [Qualitative Scales](#)
 - [Actions](#)
 - [Criteria](#)
 - [Scenarios](#)
 - [Classes](#)
 - [Action Categories](#)
 - [Criteria Groups](#)
 - [Clusters](#)
 - [Coalitions](#)
- [Options](#)

New

When you click "File | New", the following dialog opens:



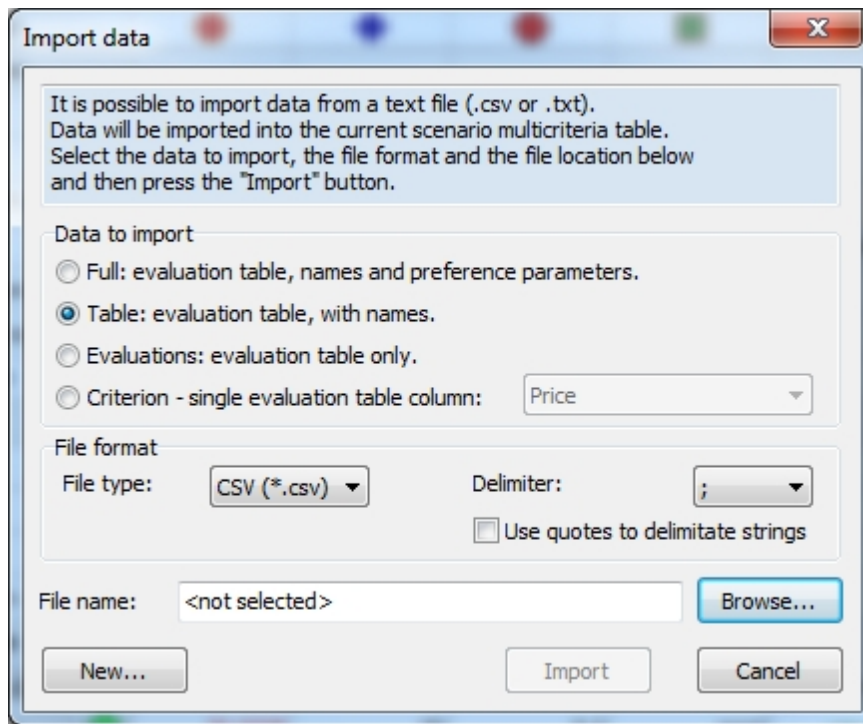
You can select the number of actions, the number of criteria and the number of scenarios.

When you press the "Ok" button an empty data set is created.

Import data

To access this dialog, click "File | Import...".

The "Import" dialog allows you to import data into a new problem. Data should be prepared in a CSV or TXT text file. This can be done easily from Excel for instance. Data will be imported into the current scenario.



From the "Import" dialog you can specify the data to import:

- Full: Evaluation table, including actions and criteria names as well as preference parameters (weights, preference functions and thresholds).
- Table: Evaluations with actions and criteria names.
- Evaluations: Evaluations only.
- Criterion: A single column of evaluations is imported. The corresponding criterion name has to be selected.

Examples of file formats are given in the Excel file provided with the Visual PROMETHEE install.

You can also specify the file format. This includes:

- The file type: either CSV or TXT.
- The delimiter in use: space, tab, semi-colon or comma.
- Whether quotes (") are used to delimitate strings or not.

Use the "Browse" button to locate the file you want to import.

Then press the "Import" button to import the data.

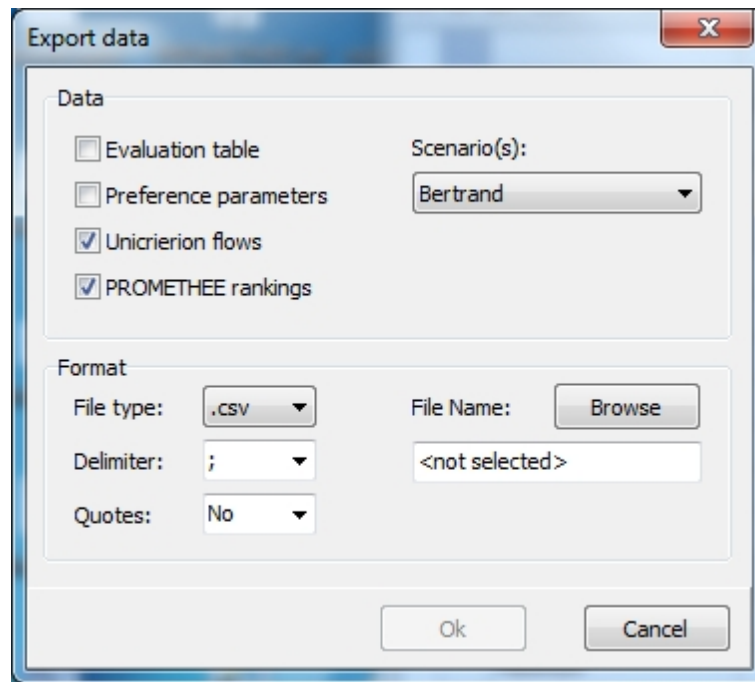
Click the "New..." button to create a new empty sheet before the import. Otherwise any existing data will be overwritten with the imported data.

Be sure that the import file is not open in Excel or any other program. Close it from Excel before you click "Import" otherwise **Visual PROMETHEE** will not be able to open the file and to import it.

Export data

To access this dialog, click "File | Export...".

You can export data to a text file for use in other software, such as for instance Excel or Word.



The "Data" section of the dialog allows you to specify what data you want to export:

- Evaluation table.
- Preference parameters (weights and preference functions).
- Unicriterion net flows.
- **PROMETHEE** rankings (multicriteria flows: Φ^+ , Φ^- and Φ).
- You can also choose which scenario you want to export.

The "Format" section allows you to control the format of the export file:

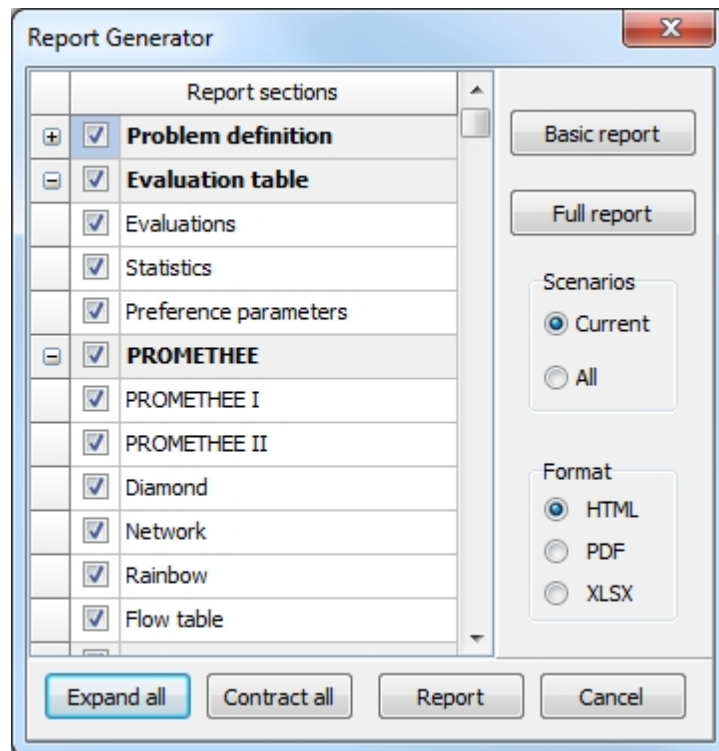
- File type: either .csv or .txt or .pm
- Delimiter: choose the delimiter used in the export file.
- Quotes: choose whether to use quotes for strings in the export file.
- Click the "Browse" button to define the name and location of the export file.

Click the "Ok" button to export the data.

Report Generator

To access this dialog, click "**File | Report...**".

The **Report Generator** allows to generate **HTML**, **PDF** or **XLS(X)** reports.



The reports are organized into a number of sections and subsections that can be selected by the user. Use the checkboxes to select which sections or subsections you want to include in the report.

Two predefined reports are available:

- Basic report: only basic data and **PROMETHEE** and **GAIA** results are included.
- Full report: all data are included.

Click the appropriate button to select one of the two predefined reports.

Two options are available with respect to the scenarios included in the report:

- Current: current scenario only.
- All: all scenarios.

Two formats are available:

- HTML: an HTML file is produced.
- PDF: a PDF file is produced. **Not fully implemented yet.**
- XLS(X): a MS Excel file is produced.

At the bottom of the window are four buttons:

- Expand all: shows all the subsections.
- Contract all: hides all the subsections.
- Report: Start the report generation.
- Cancel: exit the dialog.

The display of the subsections can also be controlled individually using the buttons to the left of the section names.

Select your options and then click the "**Report**" button to generate the report. A dialog will open to let you specify the name and location of the report. A separate folder named after the report name with an "_Images" extension and containing the source files of the images contained in the report is also generated.

PROMETHEE Certificate

To access this dialog, click: "**File | PROMETHEE Certificate...**".

How can you tell that the analysis you made is correct?

How can you tell that the analysis you are shown by a third party is correct?

That will be possible with **Visual PROMETHEE**.

This feature is not implemented yet and will be available only in the Business Edition of **Visual PROMETHEE**.

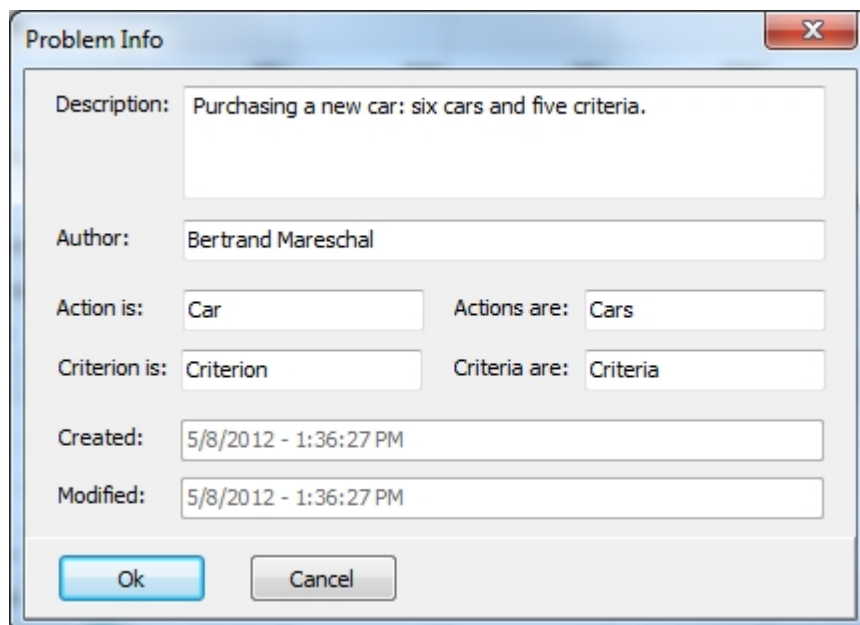
Model

- [Problem Info](#)
- [Qualitative Scales](#)
- [Actions](#)
 - [Location](#)
- [Criteria](#)
- [Scenarios](#)
- [Classes](#)
- [Action Categories](#)
- [Criteria Groups](#)
- [Clusters](#)
- [Coalitions](#)

Problem Info

To access this dialog, click: "**Model | Info...**".

This dialog allows you to enter some general information related to the current problem.



The screenshot shows the 'Problem Info' dialog box. It has a title bar with the text 'Problem Info' and a close button (X). The dialog contains the following fields:

- Description: Purchasing a new car: six cars and five criteria.
- Author: Bertrand Mareschal
- Action is: Car
- Actions are: Cars
- Criterion is: Criterion
- Criteria are: Criteria
- Created: 5/8/2012 - 1:36:27 PM
- Modified: 5/8/2012 - 1:36:27 PM

At the bottom of the dialog are two buttons: 'Ok' and 'Cancel'.

You can specify:

- A description of the problem.
- The name of the author.
- Custom description of action (and plural): for instance in the example we are comparing car(s).

- Custom description of criterion (and plural): it could indicator(s) for instance.

Press the "Ok" button to confirm.

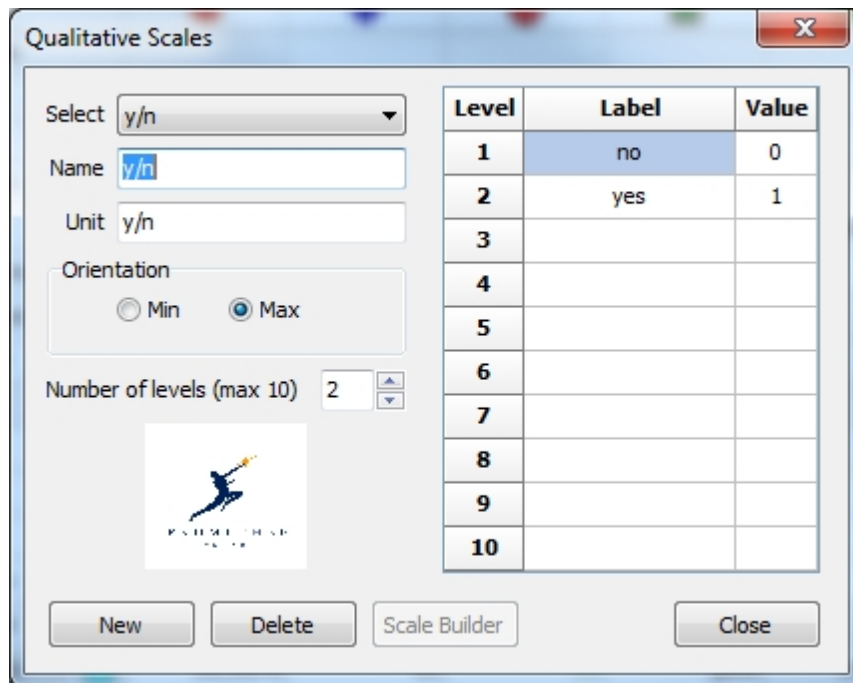
Qualitative Scales

To access this dialog, click: "**Model | Qualitative scales...**".

This is where you can define and manage qualitative scales.

There are four standard qualitative scales that are predefined when you create a new problem. These are:

- y/n: a simple 2-level scale.
- impact: this is a 5-level scale ranging from "very low" (best) to "very high" (worst) ; it is adequate for e.g. environmental or social impacts.
- 5-point: this is the classical 5-level scale ranging from "very good" to "very bad".
- 9-point: this extends the 5-point scale by adding intermediate levels.



The dialog box titled "Qualitative Scales" contains the following elements:

- Select:** A dropdown menu currently showing "y/n".
- Name:** A text field containing "y/n".
- Unit:** A text field containing "y/n".
- Orientation:** Two radio buttons, "Min" and "Max", with "Max" selected.
- Number of levels (max 10):** A spin box set to "2".
- Table:** A table with 3 columns: Level, Label, and Value.

Level	Label	Value
1	no	0
2	yes	1
3		
4		
5		
6		
7		
8		
9		
10		
- Buttons:** "New", "Delete", "Scale Builder", and "Close".

To create a new scale, click the "New" button, set the number of levels and fill all the fields.

The maximum number of levels is set to 10. In practice you should try to keep the number of levels in a qualitative scale as low as possible (preferably no more than five) to ensure a consistent evaluation.

Each level is associated to a numerical value. When the number of levels is low, they are usually quite different from each other and you will probably use the usual preference function, so that actual values are not important. What is important is the order: from best to worst. Check that the "Orientation" is consistent with your choice.

You can also modify existing scales.

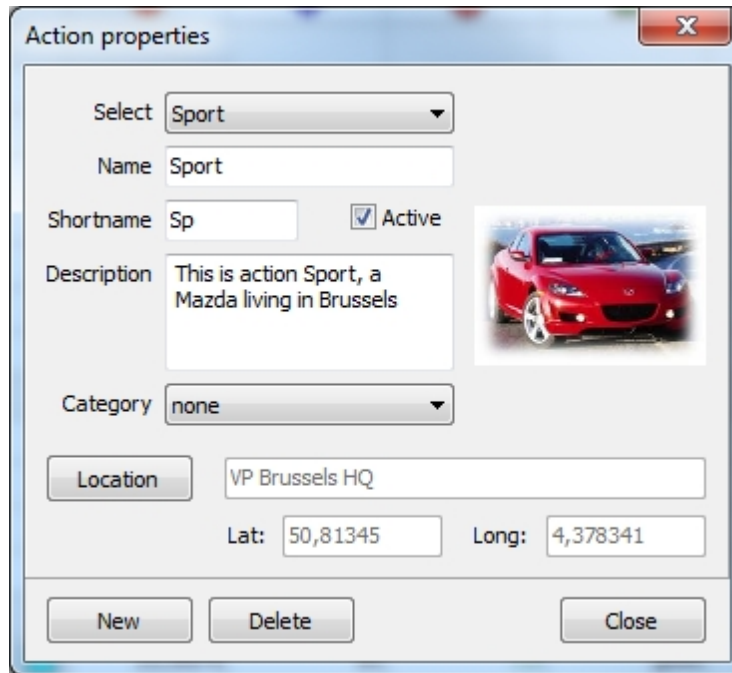
Scales are saved with the problem data and are thus problem-dependent. You can have different scales in different problems.

Click "Close" to exit.

Actions

To access this dialog, click: "**Model | Actions...**".

Here you can set the main properties of the [actions](#).



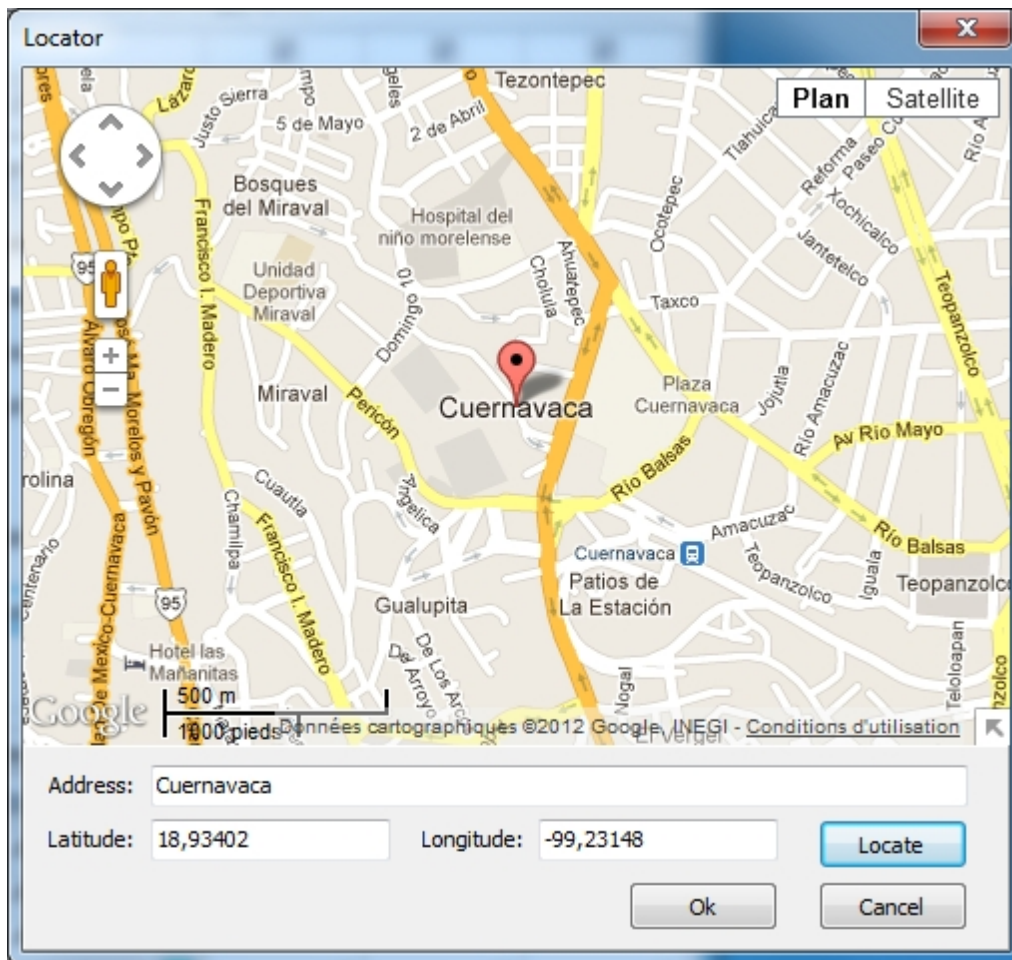
- Select: Let you select one action.
- Name: To change the action name.
- Shortname: To change the action short name.
- Active: To activate/deactivate the action (deactivated actions are not taken into account in the computation).
- Description: Enter a description of the action.
- Picture: Click on the picture to change the picture linked to the action.
- Category: Select the category to which the action belongs.
- Location: Click to set the geo-localization of the action. This opens the [Location](#) dialog.

Click "New" to add a new action or "Delete" to delete the current action.

Click "Close" to close the window.

[Location](#)

To access this dialog click the **Location** button in the [Actions](#) dialog.



This is a Google Maps window (Internet connection is required).

You can enter an address in the **Address** field and click on the **Locate** button to find it and center the map on the address.

You can also use the usual Google Maps controls and navigate to find the location on the map.

Criteria

To access this dialog, click: "**Model | Criteria...**".

Here you can set the main properties of the [criteria](#).

- Select: Let you select one criterion.
- Name: To change the criterion name.
- Shortname: To change the criterion short name.
- Active: To activate/deactivate the criterion (deactivated criteria are not taken into account in the computation).
- Description: Enter a description of the criterion.
- Group: Select the criterion group to which the criterion belongs.
- Unit: Set the unit of measurement of the criterion.
- Scale: You can select the type of scale that will be use for the criterion. There are three possibilities:
 - numerical: numbers,
 - currency: evaluations will be displayed as a currency using the symbol and formats specified on the "Currency" row.
 - qualitative: [qualitative scale](#), select the name of the scale in the drop-down list below.
- Decimals: Set the number of decimal places to display for this criterion.

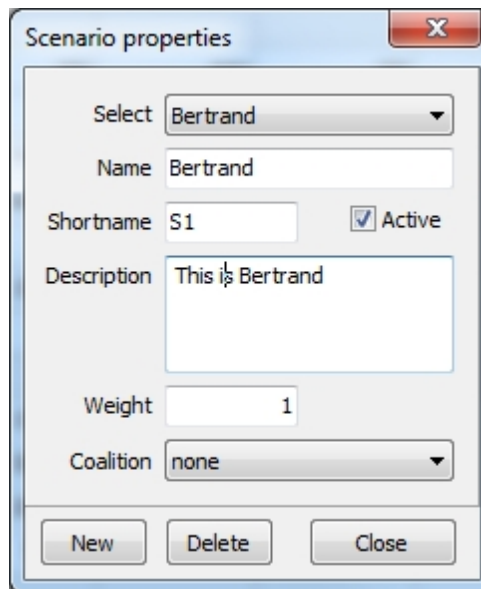
Click "New" to add a new criterion or "Delete" to delete the current criterion.

Click "Close" to close the window.

Scenarios

To access this dialog, click: "**Model | Scenarios...**".

Here you can set the main properties of the [scenarios](#).



- Select: Let you select one scenario.
- Name: To change the scenario name.
- Shortname: To change the scenario short name.
- Active: To activate/deactivate the scenario (deactivated scenarios are not taken into account in the computation).
- Description: Enter a description of the scenario.
- Weight: Set the weight of the scenario.
- Coalition: To select the [coalition](#) this scenario belongs to.

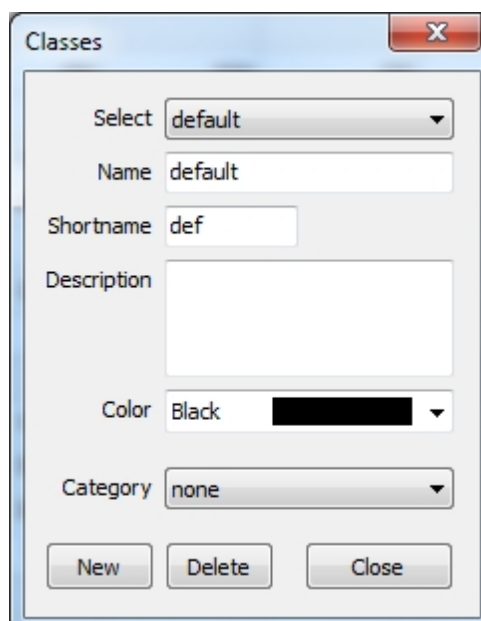
Click "New" to add a new action or "Delete" to delete the current criterion.

Click "Close" to close the window.

Classes

To access this dialog, click: "**Model | Classes...**".

Here you can define and set the properties of the [classes](#).



- **Select:** Let you select one class.
- **Name:** To change the class name.
- **Shortname:** To change the class short name.
- **Description:** Enter a description of the class.
- **Color:** Color associated to the class.
- **Category:** Select the action category that defines the class. That category should include either boundary or central profile(s) for the class.

Click "New" to add a new class or "Delete" to delete the current class.

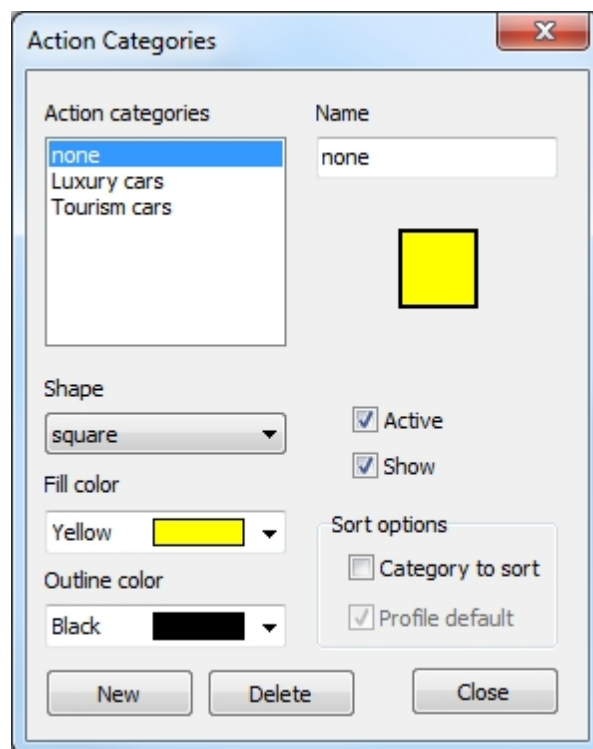
Click "Close" to close the window.

Action Categories

To access this dialog, click "**Model | Action categories...**".

Visual PROMETHEE allows you to define action [categories](#). Each action category is identified by a specific symbol and fill and outline colors. This can be useful to identify subsets of actions according to some characteristics such as e.g. localization, nationality, technology, etc.

Each action belongs to one category. There is a default category named "none". When you define a new action it is automatically assigned to the "none" category.



From this dialog you can edit existing categories or create new ones.

The "**Action categories**" list let you select one existing category.

- **Name:** Let you change the name of the selected category.
- **Shape:** Let you select the shape for the selected category.
- **Fill color:** Let you select the color that will fill the selected shape.
- **Outline color:** Let you select the outline color for the selected shape.
- **Active:** To activate/deactivate the category (deactivated categories are not taken into account in the computation).

- **Show:** To activate/deactivate the display of the actions within the category. **This feature is not implemented yet.**
- **Sort options:**
 - **Category to sort:** Determines whether the actions within the current category have to be considered in **PROMETHEE Sort**.
 - **Profile:** Shows whether the current category is a profile category for a class.

Click "**New**" to add a new category or "**Delete**" to delete the current category.

Click "**Close**" to close the window.

Criteria Groups

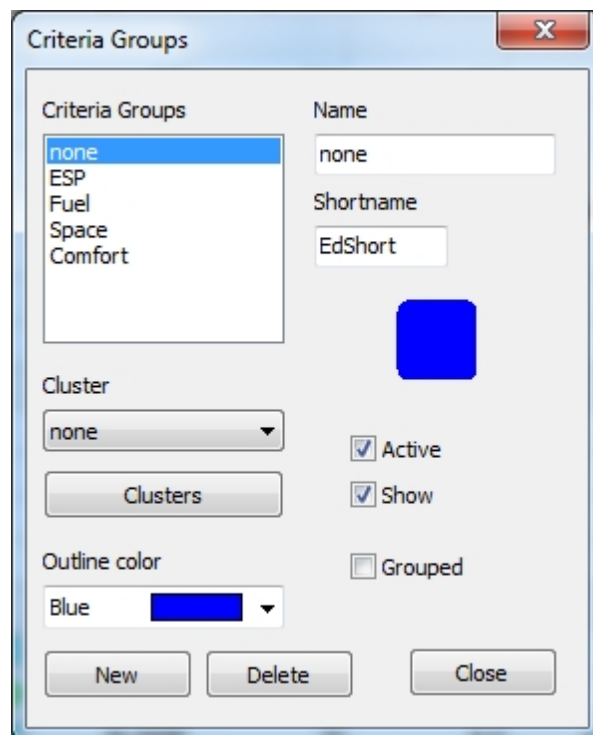
To access this dialog, click: "**Model | Criteria groups...**".

Visual PROMETHEE allows to organize [criteria](#) in a three-level hierarchy:

- at the bottom level are the individual criteria,
- each criterion belongs to a [criteria group](#),
- each criterion group belongs to a [cluster](#).

Each criterion belongs to one group. There is a default group named "none". When you define a new criterion it is automatically assigned to the "none" group.

The [Hierarchy Assistant](#) can be used to facilitate the setup of the criteria groups and clusters.



From this dialog you can edit existing criteria groups or create new ones.

The "Criteria Groups" list let you select one existing criteria group.

- **Name:** Let you change the name of the selected group.
- **Shortname:** Let you change the shortname of the selected group.
- **Cluster:** Let you select the cluster to which the selected group belongs.
- **Clusters button:** Let you manage [clusters](#).

- Outline color: Let you select the outline color for the selected group.
- Active: To activate/deactivate the group (deactivated groups are not taken into account in the computation).
- Show: To activate/deactivate the display of the criteria within the group. **This feature is not implemented yet.**
- Grouped: When checked all the criteria within the group are considered and appear as a single dimension. The weights of the criteria within the group are always kept in the same relation even when the weight of the group is modified.

Click "New" to add a new group or "Delete" to delete the current group.

Click "Close" to close the window.

Clusters

To access this dialog, click: "**Model | Clusters...**".

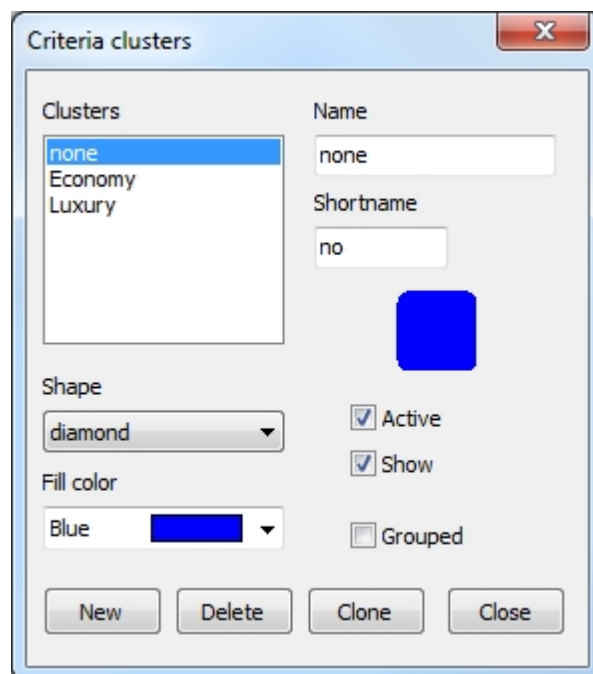
Visual PROMETHEE allows to organize criteria in a three-level [hierarchy](#):

- at the bottom level are the individual [criteria](#),
- each criterion belongs to a [criteria group](#),
- each criterion group belongs to a [cluster](#).

Each criterion belongs to one group. There is a default group named "none". When you define a new criterion it is automatically assigned to the "none" group.

There is a default cluster named "none". The "none" group as well as any new defined group are automatically assigned to the "none" cluster.

The [Hierarchy Assistant](#) can be used to facilitate the setup of the criteria groups and clusters.



From this dialog you can edit existing clusters or create new ones.

The "Clusters" list let you select one existing cluster.

- Name: Let you change the name of the selected cluster.

- Shortname: Let you change the shortname of the selected cluster.
- Shape: Let you select the shape for the selected cluster.
- Fill color: Let you select the fill color for the selected shape.
- Active: To activate/deactivate the cluster (deactivated clusters are not taken into account in the computation).
- Show: To activate/deactivate the display of the criteria within the cluster. **This feature is not implemented yet.**
- Grouped: When checked all the criteria within the cluster are considered and appear as a single dimension. The weights of the criteria within the cluster are always kept in the same relation even when the weight of the cluster is modified.

Click "New" to add a new cluster or "Delete" to delete the current cluster.

Click "Clone" to automatically create a new criteria group with the same attributes as the current cluster. This is handy to quickly setup a simple two-level hierarchy and still benefit from all the color-coded features of the three-level hierarchy. The criteria group is allocated to the current cluster.

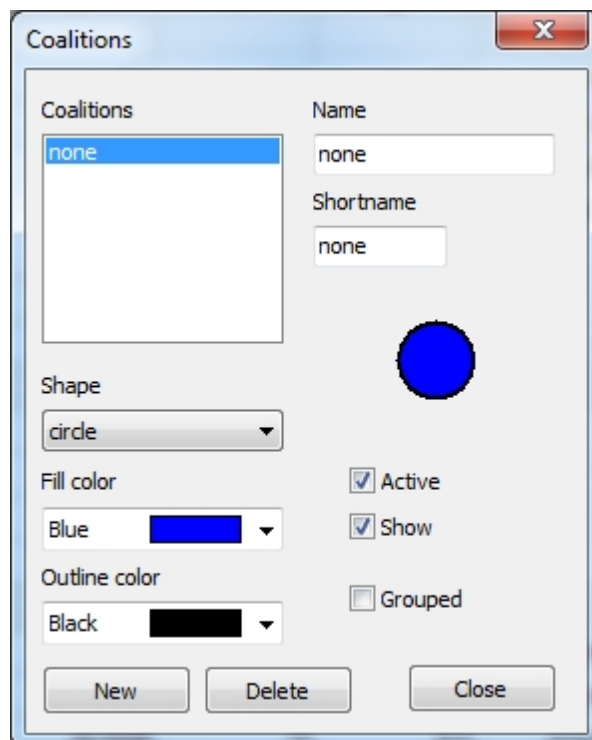
Click "Close" to close the window.

Coalitions

To access this dialog, click: "**Model | Coalitions...**".

Visual PROMETHEE allows to organize [scenarios](#) into different [coalitions](#) with specific shape, outline and fill color.

Each scenario belongs to one coalition. There is a default coalition named "none". When a new scenario is defined it is automatically assigned to the "none" coalition.



From this dialog you can edit existing coalitions or create new ones.

The "Coalitions" list let you select one existing coalition.

- Name: Let you change the name of the selected coalition.

- Shortname: Let you change the shortname of the selected coalition.
- Shape: Let you select the shape for the selected coalition.
- Fill color: Let you select the fill color for the selected shape.
- Outline color: Let you select the outline color for the selected shape.
- Active: To activate/deactivate the coalition (deactivated coalitions are not taken into account in the computation). **This feature is not implemented yet**
- Show: To activate/deactivate the display of the scenarios within the coalition. **This feature is not implemented yet.**
- Grouped: When checked all the scenarios within the coalition are considered and appear as a single dimension. The weights of the scenarios within the coalition are always kept in the same relation even when the weight of the coalition is modified. **This feature is not implemented yet**

Click "New" to add a new coalition or "Delete" to delete the current coalition.

Click "Close" to close the window.

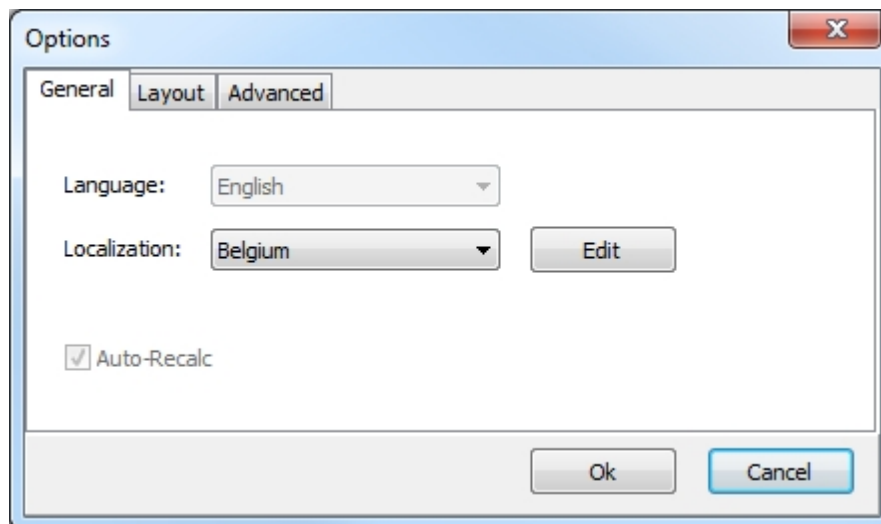
Options

The **Options** dialog contains three tabs:

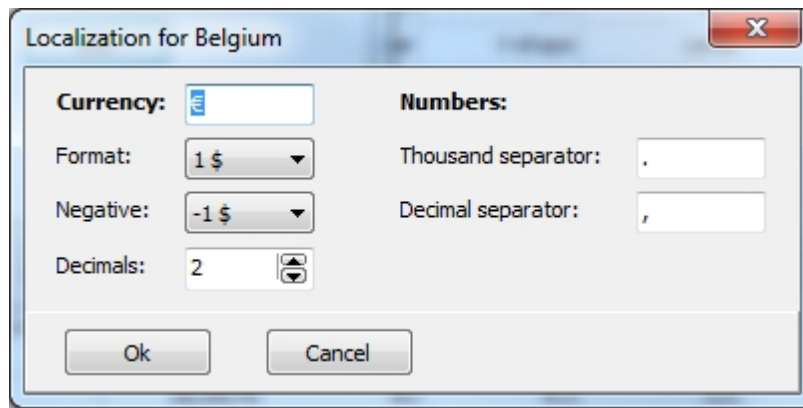
- [General](#)
- [Layout](#)
- [Advanced](#)

General

Currently the only operational options are for localization of the data.



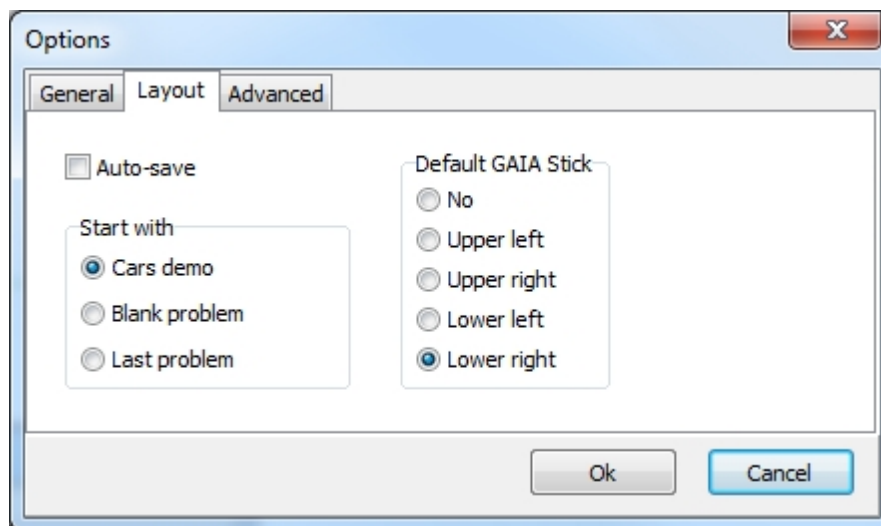
Several countries are predefined including Belgium, México, United Kingdom and the United States. It is also possible to define custom locations. Depending on the selection, numbers and currency values will be displayed differently. The formats can be checked and modified by clicking the "Edit" button.



As seen on the above screenshot, it is possible to define the currency symbol, the currency format and number of decimal places. Thousand and decimal separators can also be modified.

Layout

From this tab you can control the behavior of **Visual PROMETHEE** when you start it.



The **Auto-Save** option is currently **not functional**.

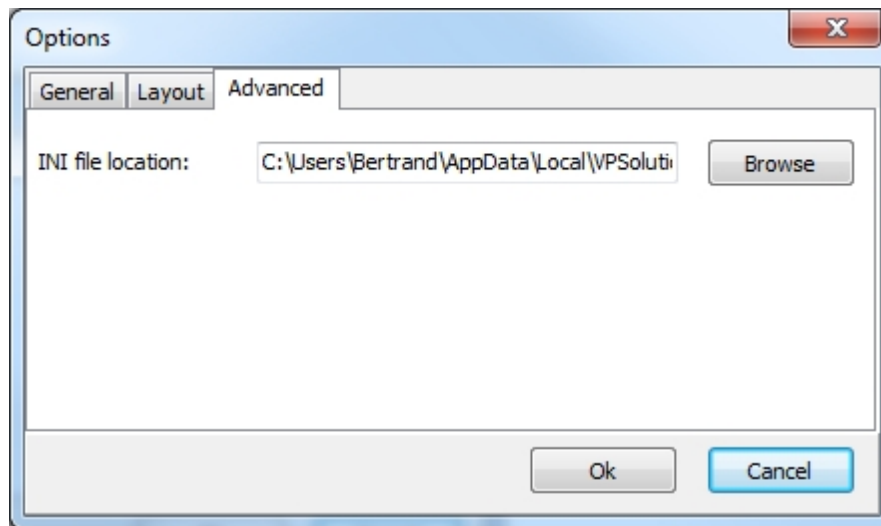
The **Start with** radio button group determines which dataset is loaded when **Visual PROMETHEE** is started:

- **Cars demo:** the cars [tutorial](#) example is loaded.
- **Blank problem:** a blank problem is created with 2 [actions](#), 1 [criterion](#) and 1 [scenario](#).
- **Last problem:** the last opened dataset is reopened.

The **Default GAIA Stick** radio button group determines where the default position of the **Decision Stick** in the **GAIA** window.

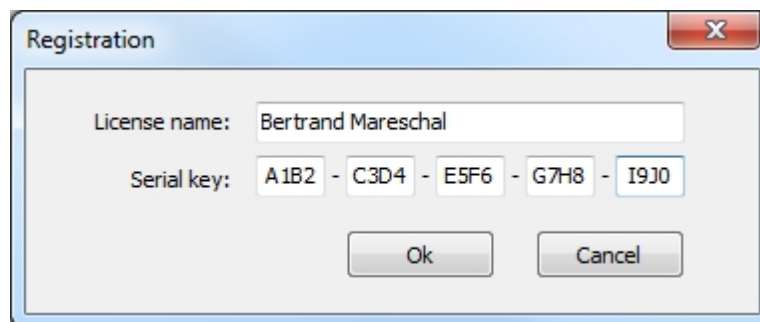
Advanced

This tab contains options for advanced users. These should not be changed unless necessary.



Registration

This dialog is used to upgrade from the [Demo Edition](#) to the [Business Edition](#).



To activate the license enter your license name and your serial key (5 groups of 4 digits) in the corresponding fields.

Press the **Ok** button to activate the **Business Edition** license.

No license or serial key are required for the **Academic Edition**.

Assistants

It is important to use tools the way they should be used. Otherwise you will end sorry. To avoid this **Visual PROMETHEE** includes several assistants to help you in the setup and analysis of your problem:

- [Problem Creation Assistant](#)
This Assistant will lead you all the way from the problem definition to the analysis of the **PROMETHEE** and **GAIA** results. **This is not yet fully implemented.**
- [Preference Function Assistant](#)
Choosing the right preference function for your criteria is essential to ensure a correct **PROMETHEE** analysis. This Assistant incorporates thirty years of experience to make sure you select the best type of preference function and assess the corresponding thresholds correctly.
- [Hierarchy Assistant](#)
This Assistant will help you to organize your criteria into clusters and criteria groups.
- [Weighing Assistant](#)
With this Assistant you will be able to assess the criteria weights visually, either directly or hierarchically to insure a proper weighing for clusters and criteria groups.
- [Analysis Assistant](#)
This Assistant is under development.

Problem Creation

This is not yet fully implemented.

Preference Function

What is it?

The **Preference Function Assistant** is designed to help you to choose a preference function type and to set the corresponding thresholds values for a given criterion.

How to use it?

To start the Preference Function Assistant click on the **Preference Fn.** cell for the criterion you want to work with and select "**Help me...**" in the drop-down list. The Preference Function Assistant will open and display the first of five pages.

At the top of the window, five tabs are available to switch from one page to an other.

At the bottom of the window are buttons to navigate from one page to the next or the previous one or to exit the Assistant.

The Preference Function Assistant

Page 1: Start

This first page contains a summary of the criterion information. From top to bottom:

- A first block of information is related to the distribution of the evaluations of the actions. It displays:
 - The type of scale of the criterion: numerical, currency or qualitative.
 - The minimum evaluation.
 - The maximum evaluation.
 - The range of the evaluations (maximum - minimum value).
 - The average evaluation.
 - The standard deviation of the evaluations.
 - Whether the criterion has to be maximized or minimized.
- A second block of information is related to the distributions of the pairwise differences between the evaluations of the actions. This is important as the preference function is a function of pairwise differences. This block displays:
 - The minimum (smallest) positive difference between the evaluations.
 - The maximum (largest) difference between the evaluations.

- The average difference.
- The standard deviation of the differences.
- A diversity measure that is equal to 100% if all the evaluations are different from each other and decreases when the number of ties increases.

Preference Function Assistant

Start | Type selection | Threshold type | Threshold assessment | End

Criterion:	Price	Evaluated on a currency scale	
Minimum value:	15,000€	Average value:	28,083€
Maximum value:	38,000€		
Range:	23,000€	Standard deviation:	7,407€

This criterion is to minimize.

PROMETHEE relies on the principle of pairwise comparison of the actions.
We will thus look at the differences between the evaluations of the actions.
Here are some statistics:

Minimum (> 0) difference:	0,500€	Average difference:	9,767€
Maximum difference:	23,000€	Standard deviation:	6,025€
Diversity:	100,0 %		

If these data are correct and you wish to setup the right preference function for this criterion, please press the "Next >" button. Otherwise, press "Cancel".

Cancel Next >

The inspection of these data can be helpful for the more experienced user.

Click the **Next >** button to proceed to Page 2 and select a preference function type.

Page 2: Type selection

At the top of the window is a question that you should answer. It is different for quantitative (as shown here) and for qualitative criteria. Depending on your answer a preference function type is suggested by the assistant ("Suggested type" at the left center of the window). Just below the suggestion you can see the currently selected type. In the screen shot, it appears in red as the currently selected type (V-shape) is different from the suggested type (Linear).

You now have several options:

- Click on the suggested type icon to select this preference function type.
- Click on any other icon to select an alternative preference function type.
- Click on the **Next >** button to proceed with the current selection.
- Click on the **< Previous** button to go back to Page 1.
- Click on the **Cancel** button to exit the Assistant.

Preference Function Assistant

Start | Type selection | **Threshold type** | Threshold assessment | End

Please answer the following question
When comparing two actions on this criterion,
Do you feel that this difference is negligible:
0,500€

☒ Yes
☐ No

Suggested type

Linear

Click to validate choice.

Selected type
V-shape

Usual V-shape U-shape Level Linear Gaussian

< Previous Cancel Next >

Click the **Next >** button to proceed to Page 3 and assess the type of thresholds you will use.

Page 3: Threshold type

A single question has to be answered to determine whether you should use absolute or percentage thresholds. If you hesitate, leave the selection as it is.

Preference Function Assistant

Start | Type selection | **Threshold type** | Threshold assessment | End

Please answer the following question

Let us compare two actions A and B on this criterion.

Case 1: A = 15,000€ - B = 19,600€

Case 2: A = 33,400€ - B = 38,000€

In both cases you should prefer A. But do you feel that your preference is:

☐ Much more important in case 1
☐ Much more important in case 2
☒ Not so different

Based on your selection, absolute thresholds seem appropriate.
You can change the selection below if you wish to do so.

Threshold type

☒ Absolute ☐ Percentage

< Previous Cancel Next >

Click the **Next >** button to proceed to Page 4 and assess the values of thresholds.

Page 4: Threshold assessment

Depending on the preference function type that has been selected up to two thresholds (Q, P or S) have to be assessed.

On the left side of the window are boxes for each threshold that has to be assessed depending on the type of preference function selected.

In each box you can see the selected value as well as the value suggested by the Assistant. You can enter a new value or click on the suggested value button to accept it.

On the right side of the window is a graphical representation of the currently selected preference function.

Several pieces of information are displayed:

- The blue rectangle represents the distribution of the pairwise differences between evaluations, from the minimum to the maximum difference, the middle bar corresponds to the average difference.
- The green rectangles show the difference between the current and suggested values for the thresholds.

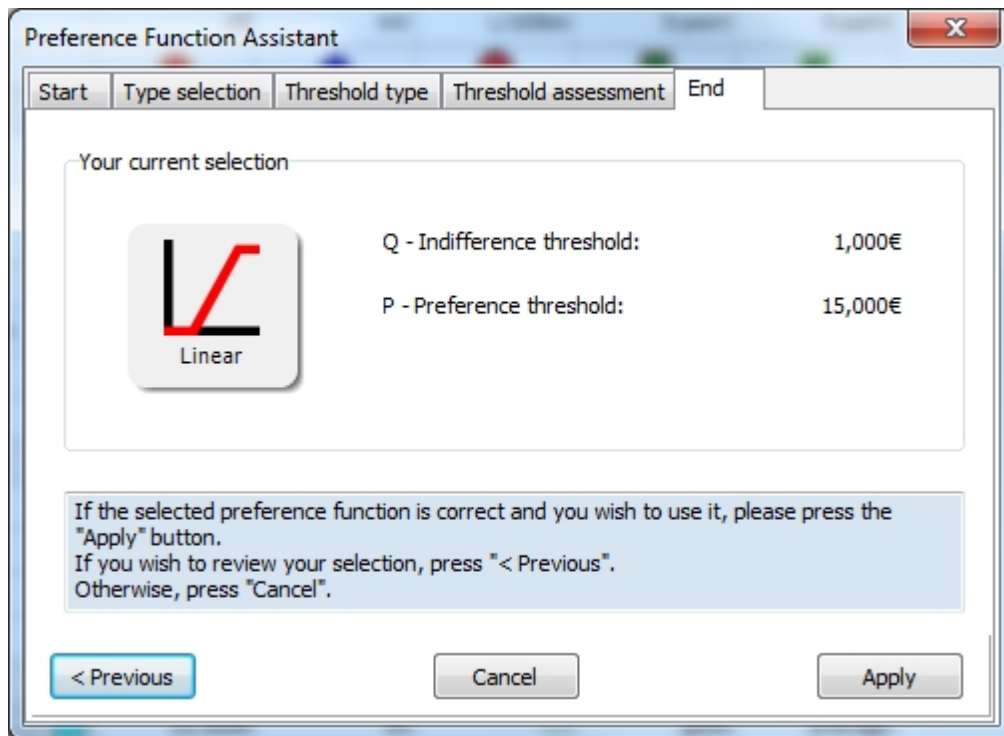
The two sliders are currently inactive.

The screenshot shows the 'Preference Function Assistant' window with the 'Threshold assessment' tab selected. The window has a title bar with standard OS controls and a close button. Below the title bar is a tabbed interface with five tabs: 'Start', 'Type selection', 'Threshold type', 'Threshold assessment' (active), and 'End'. The main content area is divided into two sections. On the left, there are two threshold assessment boxes. The first box is for 'Q: Indifference threshold' and contains two sub-sections: 'Selection' with a text input field showing '1,000€' and a 'Suggested' button showing '6,025€'. The second box is for 'P: Preference threshold' and contains two sub-sections: 'Selection' with a text input field showing '15,000€' and a 'Suggested' button showing '15,791€'. On the right, there is a graphical representation of the preference function. It shows a red line that starts at the origin, increases linearly, and then levels off to a horizontal line. A blue rectangle is overlaid on the graph, representing the distribution of pairwise differences. Below the graph, there are two sliders labeled 'Q:' and 'P:'. Both sliders are currently inactive, indicated by a greyed-out appearance. At the bottom of the window, there are three buttons: '< Previous' (disabled), 'Cancel', and 'Next >' (active).

Click the **Next >** button to proceed to Page 5 and validate your choice.

Page 5: End

This page displays your current selection.



Click the **Apply** button to proceed to validate your choice.

Criteria Hierarchy

What is it?

The **Criteria Hierarchy Assistant** is designed to help you to define the criteria hierarchy.

How to use it?

To start the Criteria Hierarchy Assistant select "**Assistants | Hierarchize...**" The Criteria Hierarchy Assistant will open and display the first of three pages.

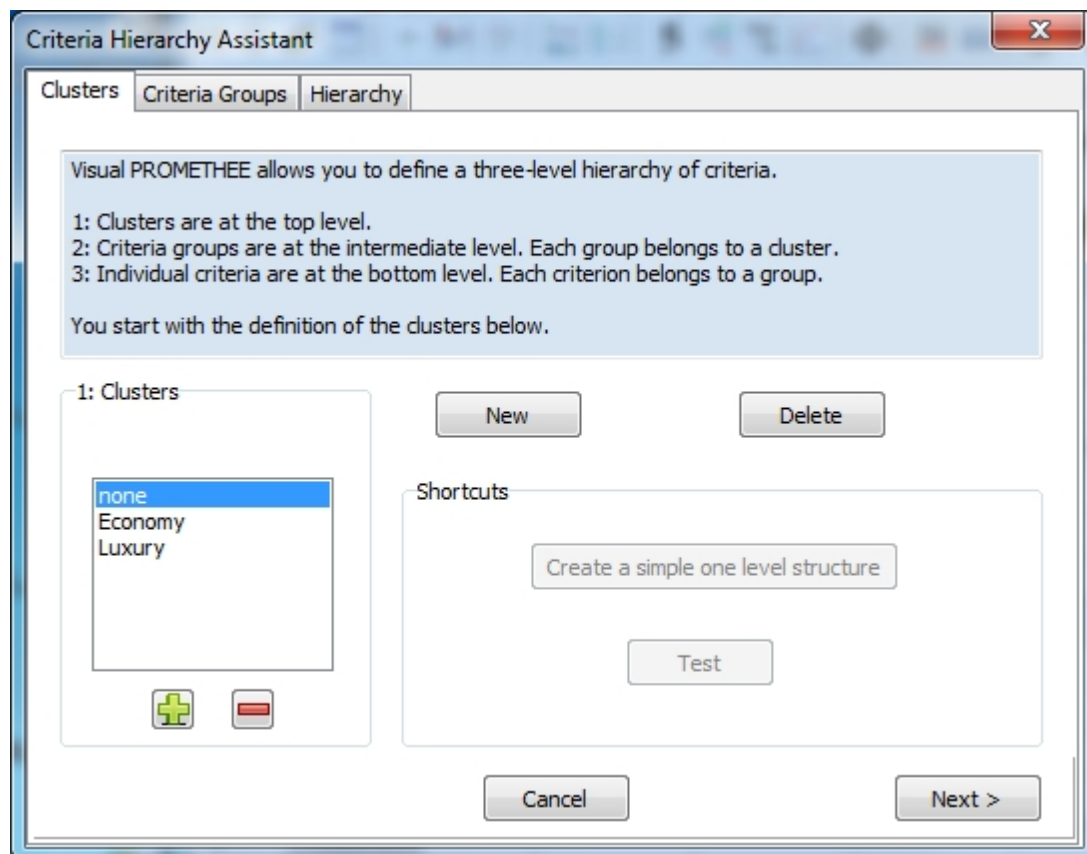
At the top of the window, three tabs are available to switch from one page to an other.

At the bottom of the window are buttons to navigate from one page to the next or the previous one or to exit the Assistant.

The Criteria Hierarchy Assistant

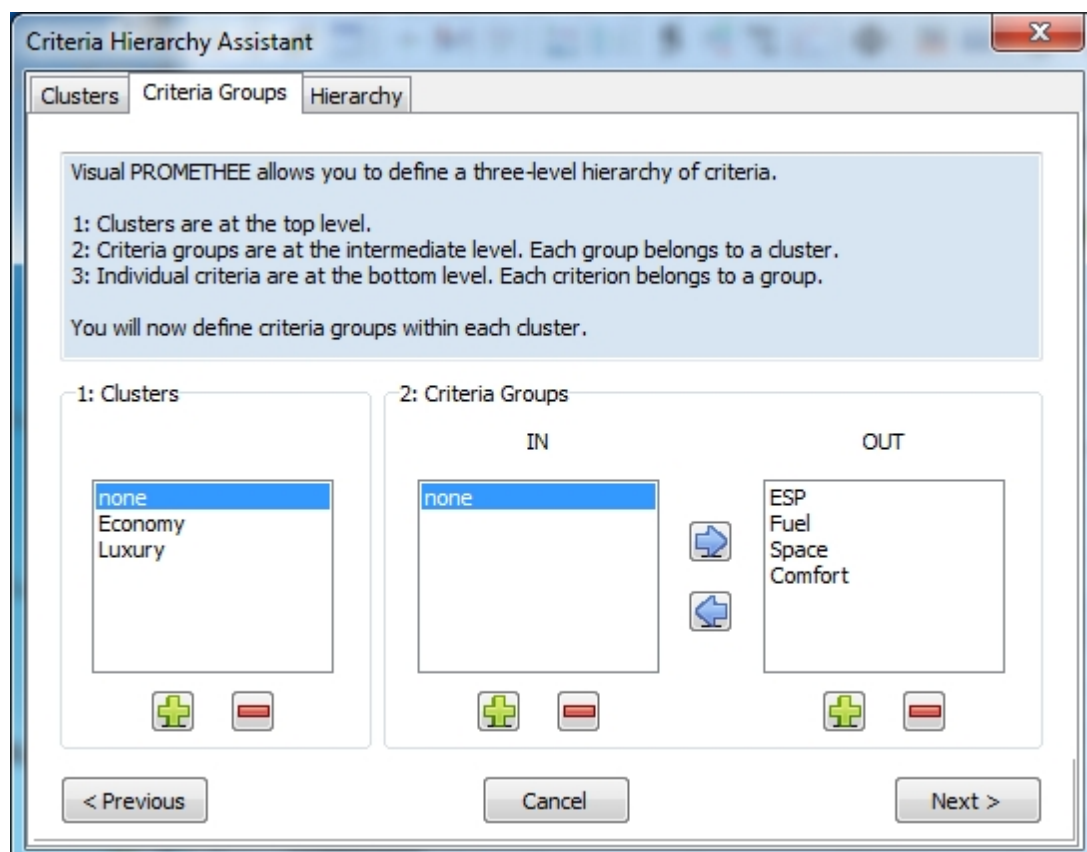
Page 1: Clusters

This first page is where you define the cluster.



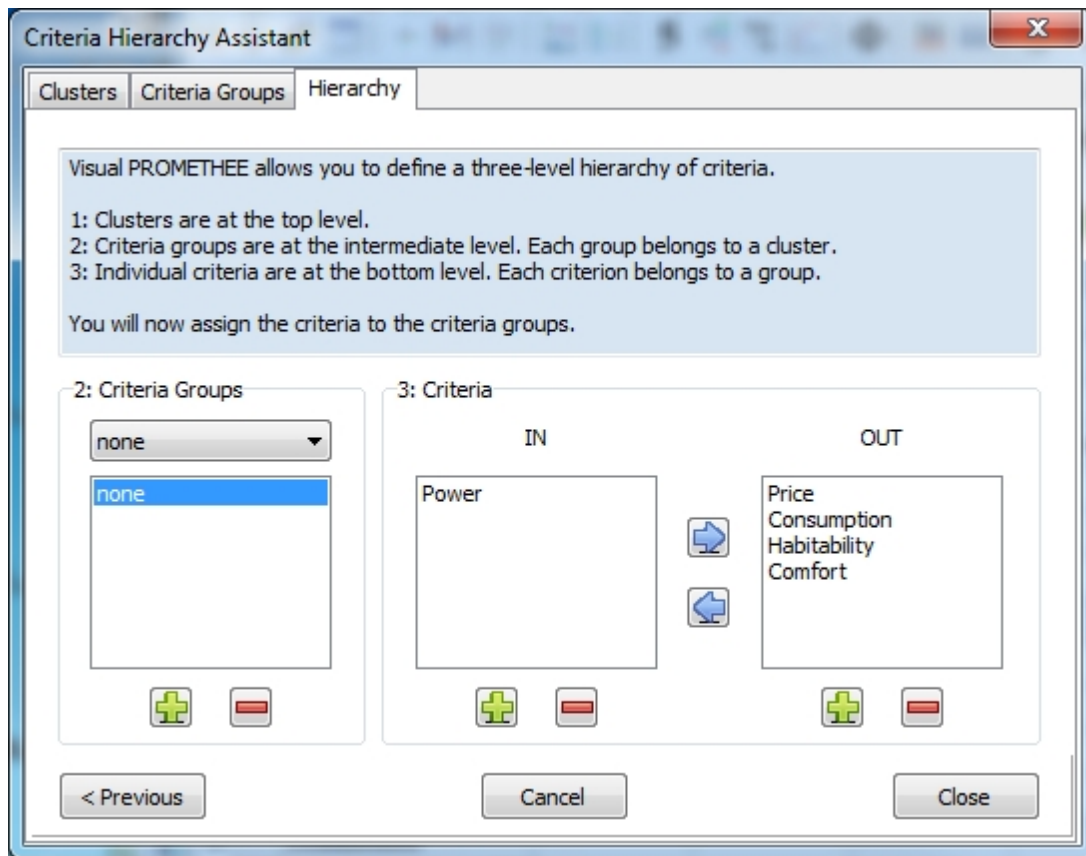
Page 2: Criteria Groups

This second page is where you define the criteria groups and assign them to the cluster. Each criteria group belongs to one cluster.



Page 3: Hierarchy

This third page is where you assign the criteria to their respective criteria groups within the hierarchy. Each criterion belongs to one criteria group.



Weighing

What is it?

The **Weighing Assistant** is designed to help you to weigh the criteria within the criteria hierarchy.

How to use it?

To start the Weighing Assistant select "**Assistants | Weigh...**" The Weighing Assistant will open. At the bottom of the window are several buttons:

- Two radio buttons allow to switch between the **Hierarchical** and **Absolute** modes.
- The **Set Equal** button is used to set all weights equal.
- The **Apply** button saves the current weights to the spreadsheet.
- The **Cancel** button exits the Assistant.

The Weighing Assistant

The Assistant can be used in two modes:

- In the hierarchical mode, weights are assigned at the three levels of the hierarchy:
 - At the top level, clusters are assigned weights.
 - At the intermediate level, criteria groups are assigned relative weights within each cluster.
 - At the bottom level, individual criteria are assigned relative weights within each criteria group.
- In the absolute mode, weights are assigned directly to all the individual criteria, independently from their criteria groups and clusters.

The Assistant window contains four columns. From left to right:

- The name of the cluster, criteria group or criterion.
- A visual five-star rating for assessing the weight: click on the stars to define the weight.

- The corresponding weight value on 0 to 100 scale (one star is equal to 20).
- The bar in the rightmost column show the resulting relative weight expressed in percent.

To the left are buttons that can be used to contract or expand the hierarchy display.

Hierarchical mode

When the Hierarchical mode is selected the following dialog is available.

Name	Mode: %	Lock	Hierarchical Weight
none	20,0%	<input type="checkbox"/>	20%
none	20,0%	<input type="checkbox"/>	20%
Power	20,0%	<input type="checkbox"/>	20%
Economy	40,0%	<input type="checkbox"/>	40%
ESP	20,0%	<input type="checkbox"/>	20%
Price	20,0%	<input type="checkbox"/>	20%
Fuel	20,0%	<input type="checkbox"/>	20%
Consumption	20,0%	<input type="checkbox"/>	20%
Luxury	40,0%	<input type="checkbox"/>	40%
Space	20,0%	<input type="checkbox"/>	20%
Habitability	20,0%	<input type="checkbox"/>	20%
Comfort	20,0%	<input type="checkbox"/>	20%
Comfort	20,0%	<input type="checkbox"/>	20%

☒ Hierarchical
 ☐ Absolute

Weights are input at all the hierarchy levels and the resulting absolute weights of the criteria are automatically computed.

Absolute mode

When the Absolute mode is selected the following dialog is available.

Weighing Assistant

Name	Mode: %	Lock	Absolute weight
none			20%
none			20%
Power	- 20,0% +	<input type="checkbox"/>	20%
Economy			40%
ESP			20%
Price	- 20,0% +	<input type="checkbox"/>	20%
Fuel			20%
Consumption	- 20,0% +	<input type="checkbox"/>	20%
Luxury			40%
Space			20%
Habitability	- 20,0% +	<input type="checkbox"/>	20%
Comfort			20%
Comfort	- 20,0% +	<input type="checkbox"/>	20%

☐ Hierarchical
 ☒ Absolute

Weights are input at the individual criteria level only. The resulting weights of the criteria groups and clusters are automatically computed.

Analysis

This is not yet implemented.

Windows

Here is a list of all the windows available in **Visual PROMETHEE**.

For a description of the **Visual PROMETHEE** main window check the [tutorial](#).

- [Activation Center](#)
- [Filter](#)
- [Sort](#)
- [PROMETHEE Rankings](#)
- [PROMETHEE Diamond](#)
- [PROMETHEE Rainbow](#)
- [PROMETHEE Table](#)
- [GAIA](#)
 - [Decision Maker Brain](#)
- [Action Profiles](#)
- [GAIA Webs](#)
- [Walking Weights](#)
- [Visual Stability Intervals](#)
- [PROMETHEE V Selection](#)
- [PROMETHEE Sort](#)
- [Performance Analysis](#)
- [Preference Flows](#)
- [Scenarios Comparison](#)
- [Balance of Power](#)
- [PROMap](#)
- [Weight Presets](#)
- [Layouts](#)

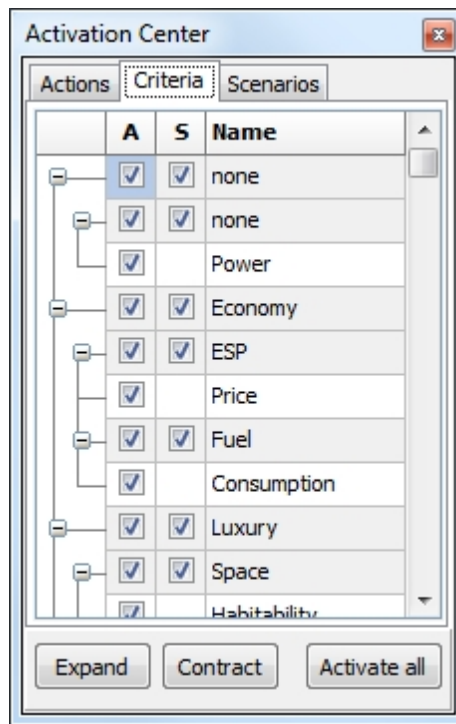
Activate

What is it?

The **Activity Center** enables you to quickly control which [actions](#), [criteria](#) or [scenarios](#) are active or not.

Activation Center

There are three tabs: Actions, Criteria and Scenarios.



From each tab you can control which actions, criteria or scenarios are active or not (checkbox **A**).

It is also possible to control which categories of actions, groups of criteria, clusters or coalitions are active (checkbox **A**) or shown on the results displays (checkbox **S**) (the **Show** feature is not operational yet).

When a category, group or cluster is activated or deactivated, all the actions or criteria belonging to that item are automatically activated or deactivated.

Use the **Expand** and **Contract** buttons to respectively expand or contract the displayed hierarchical tree.

Use the **Activate all** button to activate all the items in the currently displayed tab.

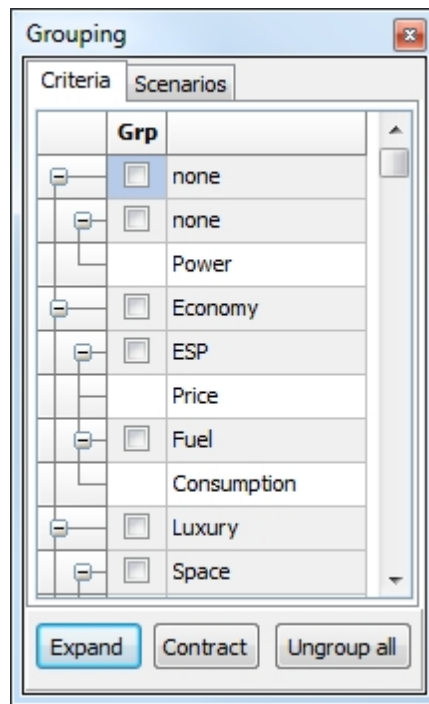
Group

What is it?

The **Grouping** window enables you to quickly control which [criteria](#) or [scenarios](#) are grouped or not.

Grouping

There are two tabs: Criteria and Scenarios.



From each tab you can control which criteria or scenarios are grouped or not (checkbox **Grp**).

Use the **Expand** and **Contract** buttons to respectively expand or contract the displayed hierarchical tree.

Use the **Ungroup all** button to ungroup all the items in the currently displayed tab.

Filter

What is it?

The **Filter** allows to deactivate actions according to criteria values.

How to interact?

- The checkboxes in the leftmost column allow to active the filtering on each criterion separately.
- The "min" and "max" columns allow to introduce the filtering range for each criterion.
- The drop-down lists allow to select "<=", "<" or "n/a". In the last case, the corresponding range value is not considered.
- The "Check all" and "Uncheck all" buttons can be used to turn on or off all the criteria filtering.
- The "Filter" button applies the active filtering to the currently active actions.

Filter

There is one row for each criterion and the filtering range can be defined separately for each criterion.

A	min		Criterion		max
<input checked="" type="checkbox"/>	20,000€	<=	Price	<=	30,000€
<input type="checkbox"/>	0	<=	Power	<=	0
<input checked="" type="checkbox"/>	0,0	n/a	Consumption	<=	8,5
<input type="checkbox"/>	0,0	<=	Habitability	<=	0,0
<input type="checkbox"/>	0,0	<=	Comfort	<=	0,0

Check all Uncheck all Filter Close

In the above example, filtering is active for two criteria:

- **Price**: only cars in the 20,000€ to 30,000€ price range (limits included) will be selected.
- **Consumption**: only cars with a consumption lower than or equal to 8,5 will be selected.

Inactive range values are displayed in gray.

Sort

What is it?

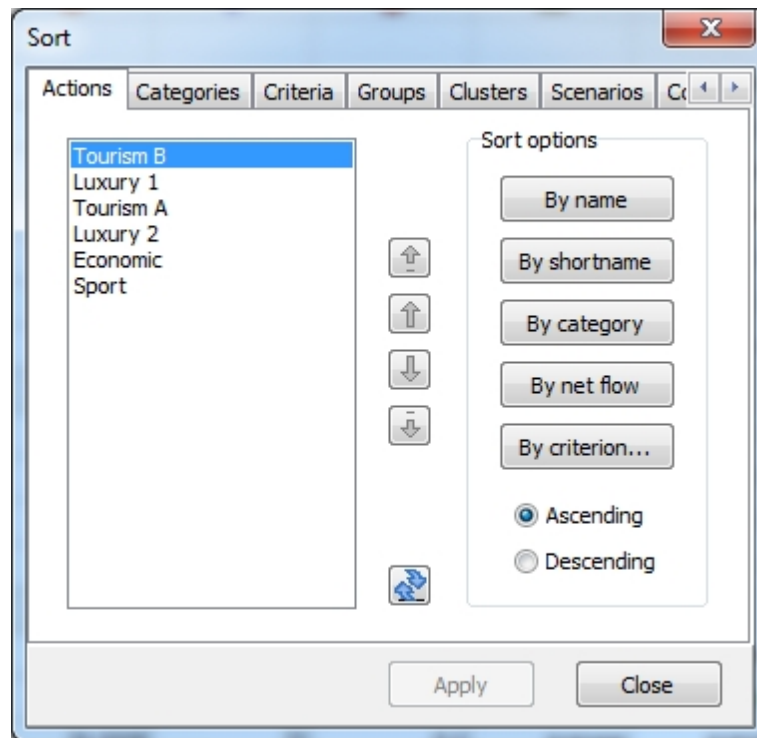
This window allows to modify the sequence of actions, criteria or scenarios in the **Visual PROMETHEE** windows.

How to interact?

- Click on the tabs at the top of the window to select the type of items you want to sort.
- Use the "Sort options" buttons to sort the items according to predefined attributes.
- Use the arrow buttons to individually move a selected item within the list of items displayed on the left side.
- Click "Apply" to sort the items.
- Click "Close" to exit the dialog.

Sort

Various options are available.



They affect the sequence in which that actions, criteria or scenarios are presented in the **Visual PROMETHEE** windows.

There are seven tabs at the top of the window:

- **Actions:** can be sorted according to their name, shortname, category name, current net flow value or criterion value.
- **Categories:** can be sorted according to their name.
- **Criteria:** can be sorted according to their name, shortname, group name or current weight.
- **Groups:** can be sorted according to their name or cluster name.
- **Clusters:** can be sorted according to their name.
- **Scenarios:** can be sorted according to their name, shortname, coalition name or weight.
- **Coalitions:** can be sorted according to their name.

A manual sort is also possible using the arrow buttons. Select an item in the listbox and use the buttons to change its position in the list.

The sort can be done either by ascending or descending values.

All sort options are not currently implemented.

PROMETHEE Rankings

What is it?

The PROMETHEE Rankings window displays the **PROMETHEE I** and **II** rankings in two separate tabs.

How to interact?

There are two tabs at the bottom of the window. You can select the **PROMETHEE I** partial ranking or the **PROMETHEE II** complete ranking.

There is also a local menu. Right-click on the drawing to open it.

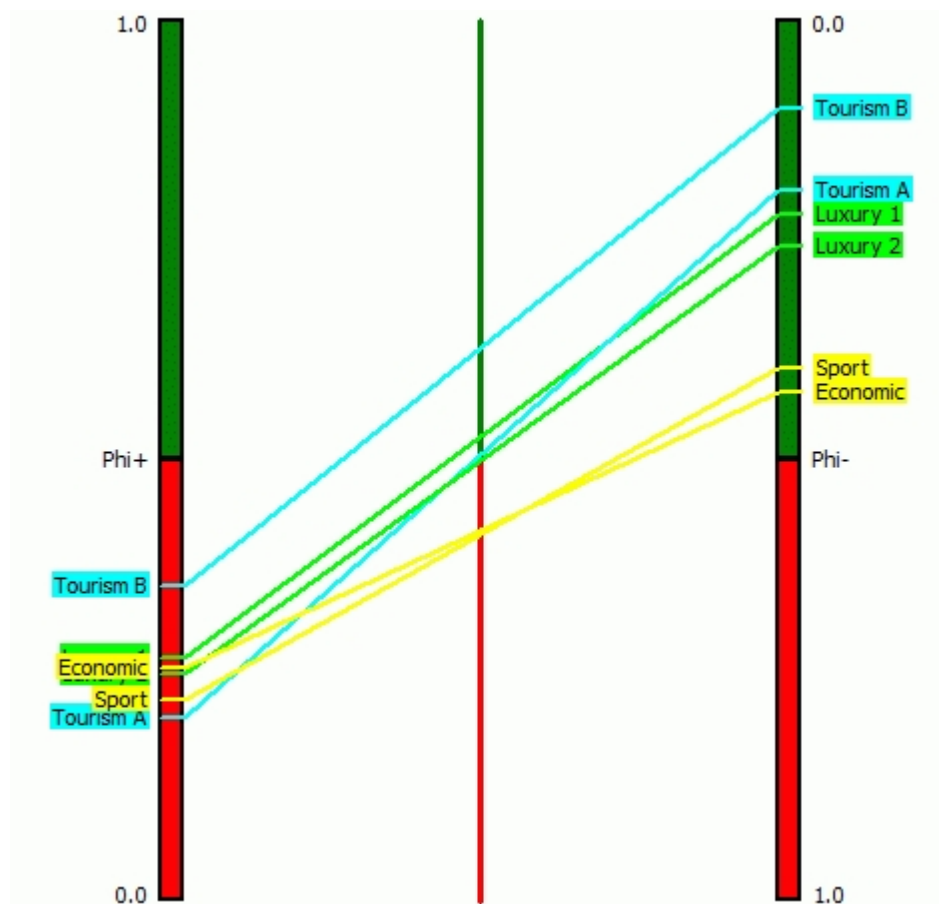
Local Menu

From the local menu the following options are available:

- Copy: Make a copy of the window to the clipboard. You will be able to paste it into another application such as e.g. Word, Excel or PowerPoint.
- Shortnames: You can choose to display the actions full names or short-names.
- Locate: You can select an action that will be highlighted on the display. That makes it easier to locate a particular action, especially when the number of actions is larger.

PROMETHEE I Partial Ranking

The **PROMETHEE I** Partial Ranking is based on the comparison of the leaving flow (Phi+) and the entering flow (Phi-).



The left column corresponds to the Phi+ scores and the right column to the Phi- scores. They are oriented such that the best scores are upwards. This way the middle column corresponds to the net flow (Phi-scores).

On the left side you can see the ranking of the actions according to Phi+.
On the right side you can see the ranking of the actions according to Phi-.

For each action a line is drawn from its Phi+ score to its Phi- score.

When a line is completely on top of another one it means that the corresponding action is better on both Phi+ and Phi-. This action is thus preferred to the other in the **PROMETHEE I** Partial Ranking.

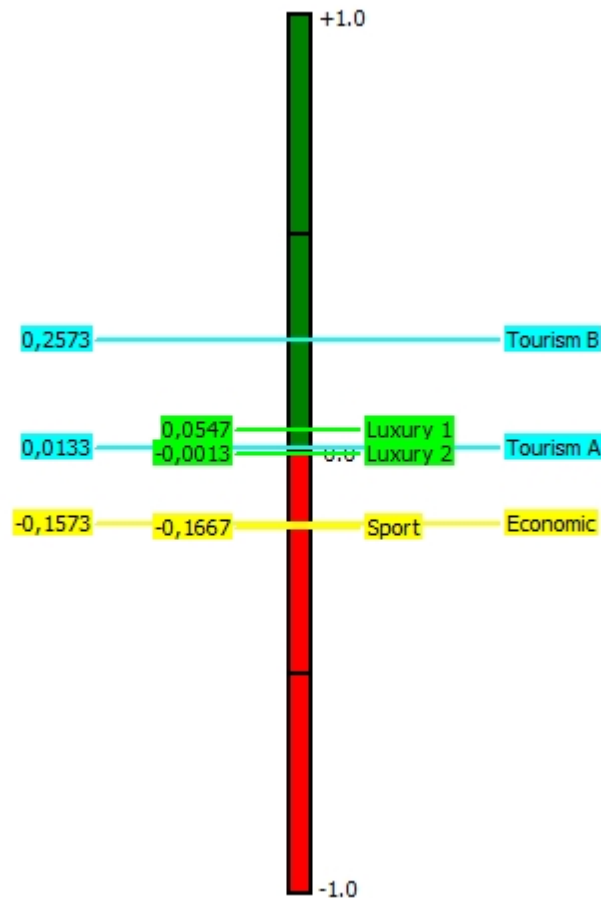
When two lines intersect the Phi+ and Phi- rankings are different and the two action are thus incomparable in the **PROMETHEE I** Partial Ranking.

For instance, in the **Visual PROMETHEE** example shown here, **Tourism B** is preferred to all the other actions. While **Sport** and **Economy** are incomparable actions.

PROMETHEE II Complete Ranking

The **PROMETHEE II** Complete Ranking is based on the net flow Φ_i .

The top half of the scale (in green) corresponds to positive Φ_i scores and the bottom half (in red) to negative scores.



In the example shown here, three groups of actions appear clearly:

- **Tourism B** is on top of all the other actions.
- **Luxury 1**, **Luxury 2** and **Tourism A** are very close to each other in the middle of the ranking.
- **Sport** and **Economy** are at the bottom of the ranking.

PROMETHEE Diamond

What is it?

The **PROMETHEE Diamond** is an alternate display of the **PROMETHEE I** and **II** rankings. It shows both rankings in one 2-dimensional representation.

How to interact?

There is a local menu. Right-click on the drawing to open it.

Local Menu

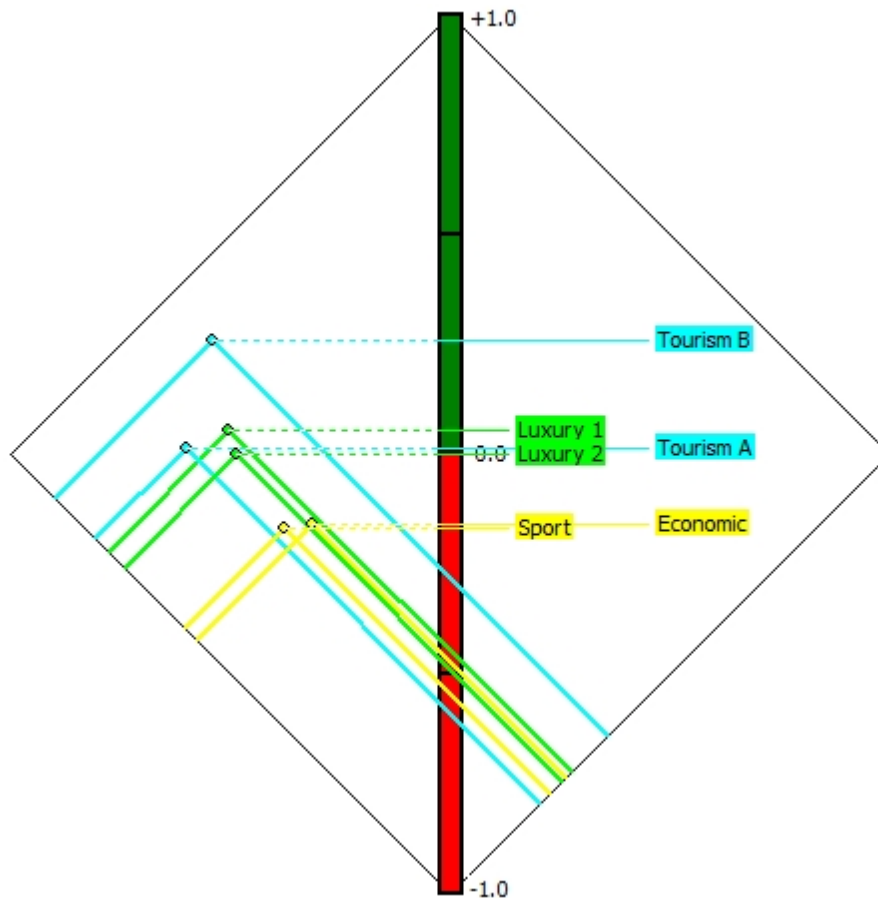
From the local menu the following options are available:

- Copy: Make a copy of the window to the clipboard. You will be able to paste it into another application such as e.g. Word, Excel or PowerPoint.
- Shortnames: You can choose to display the actions full names or short-names.
- Locate: You can select an action that will be highlighted on the display. That makes it easier to locate a

particular action, especially when the number of actions is larger.

PROMETHEE Diamond

In the **PROMETHEE Diamond** each action is represented as a point in the (Phi+,Phi-) plane. The plane is angled 45° degrees so that the vertical dimension (green-red axis) corresponds to the Phi net flow.



A cone is drawn for each action. When a cone is overlapping another one it means that the action is preferred to the other one in the **PROMETHEE I** Partial Ranking. Intersecting cones correspond to incomparable actions.

In the example, **Tourism B** is clearly preferred to all the other actions, while **Sport** and **Economic** are incomparable.

The vertical dimension corresponds to Phi, so it is possible to visualize both **PROMETHEE** rankings at the same time.

PROMETHEE Network

What is it?

The **PROMETHEE Network** is an alternate display of the **PROMETHEE I** ranking.

How to interact?

There is a local menu. Right-click on the drawing to open it.

Local Menu

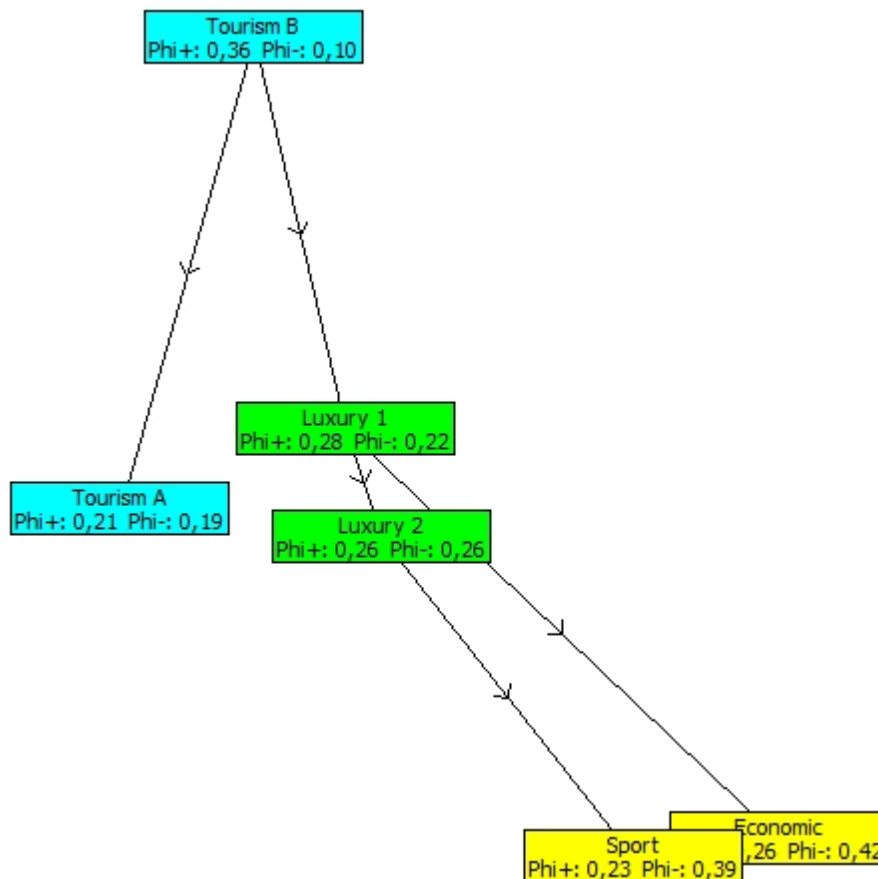
From the local menu the following options are available:

- Copy: Make a copy of the window to the clipboard. You will be able to paste it into another application such as e.g. Word, Excel or PowerPoint.

- Shortnames: You can choose to display the actions full names or short-names.
- Show flows: You can choose to display the Phi+ and Phi- values or not.
- Locate: You can select an action that will be highlighted on the display. That makes it easier to locate a particular action, especially when the number of actions is larger.

PROMETHEE Network

In the **PROMETHEE Network** display each action is represented as a node and preferences are represented by arrows. The nodes are located in relative positions corresponding to the [PROMETHEE Diamond](#) so that the proximities between flow values appear clearly.



In the example, **Tourism B** is clearly preferred to all the other actions, while **Sport** and **Economic** are incomparable but very close to each other.

PROMETHEE Rainbow

What is it?

The **PROMETHEE Rainbow** is a disaggregated view of the **PROMETHEE II** complete ranking. It shows the detail of the Phi net flow computation, emphasizing the good and weak features of each action.

How to interact?

There is a local menu. Right-click on the drawing to open it.

Local Menu

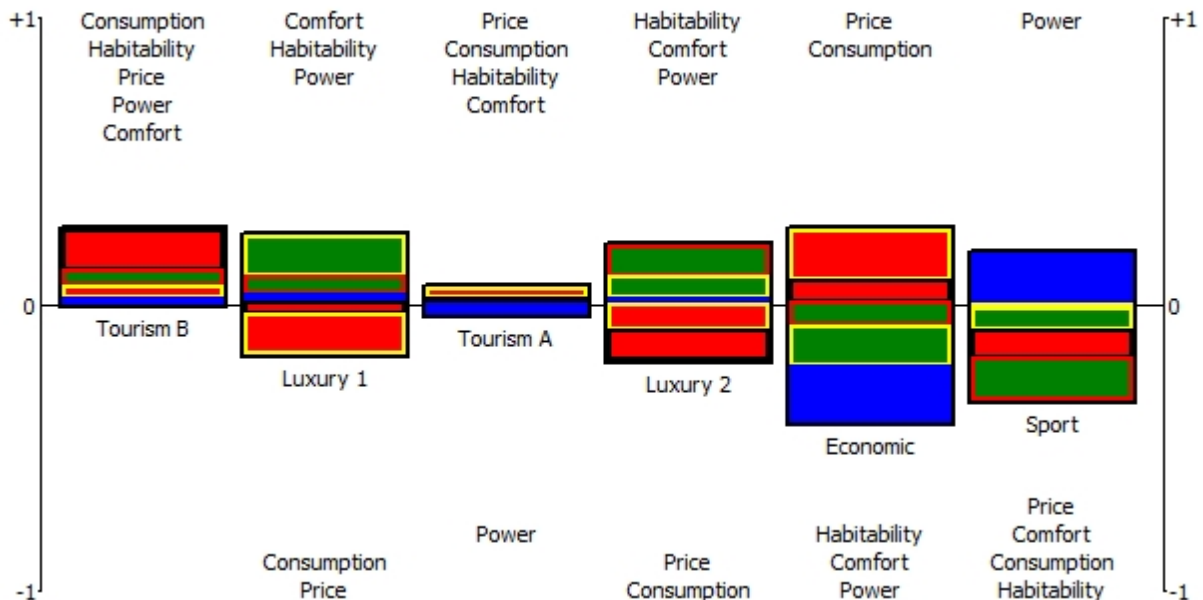
From the local menu the following options are available:

- Copy: Make a copy of the window to the clipboard. You will be able to paste it into another application such as e.g. Word, Excel or PowerPoint.
- Show criteria: Control whether the names of the criteria are displayed or not.

- Shortnames: You can choose to display the actions and/or criteria full names or short-names.

PROMETHEE Rainbow

For each action a bar is drawn. The different slices of each bar are colored according to the criteria. Each slice is proportional to the contribution of one criterion (flow value times the weight of the criterion) to the Phi net flow score of the action. Positive (upward) slices correspond to good features while negative (downward) slices correspond to weaknesses. This way, the balance between positive and negative slices is equal to the Phi score. Actions are ranked from left to right according to the **PROMETHEE II Complete Ranking**.



In the example, **Tourism B** shows no weaknesses. **Tourism A** seems very average. And **Economic** exhibits some very good features as well as some very weak features.

It is best to use various groups and/or clusters with contrasted colors to visually identify the slices.

PROMETHEE Table

What is it?

The **PROMETHEE Table** window displays the **PROMETHEE** preference flows in a tabular format.

How to interact?

There is a local menu. Right-click on the drawing to open it.







Local Menu

From the local menu the following options are available:

- Copy: Make a copy of the window to the clipboard. You will be able to paste it into another application such as e.g. Word, Excel or PowerPoint.

PROMETHEE Table

This is a table where actions are ranked according to the **PROMETHEE II Complete Ranking**. The Phi, Phi+ and Phi- scores are displayed.

PROMETHEE Flow Table					
Rank	Car		Phi	Phi+	Phi-
1	Tourism B		0,2573	0,3573	0,1000
2	Luxury 1		0,0547	0,2760	0,2213
3	Tourism A		0,0133	0,2060	0,1927
4	Luxury 2		-0,0013	0,2560	0,2573
5	Economic		-0,1573	0,2647	0,4220
6	Sport		-0,1667	0,2280	0,3947

GAIA

What is it?

The GAIA window displays the results of the **GAIA** analysis.

How to interact?

- There is a local menu. Right-click on the drawing to open it.

Local Menu

From the local menu the following options are available:

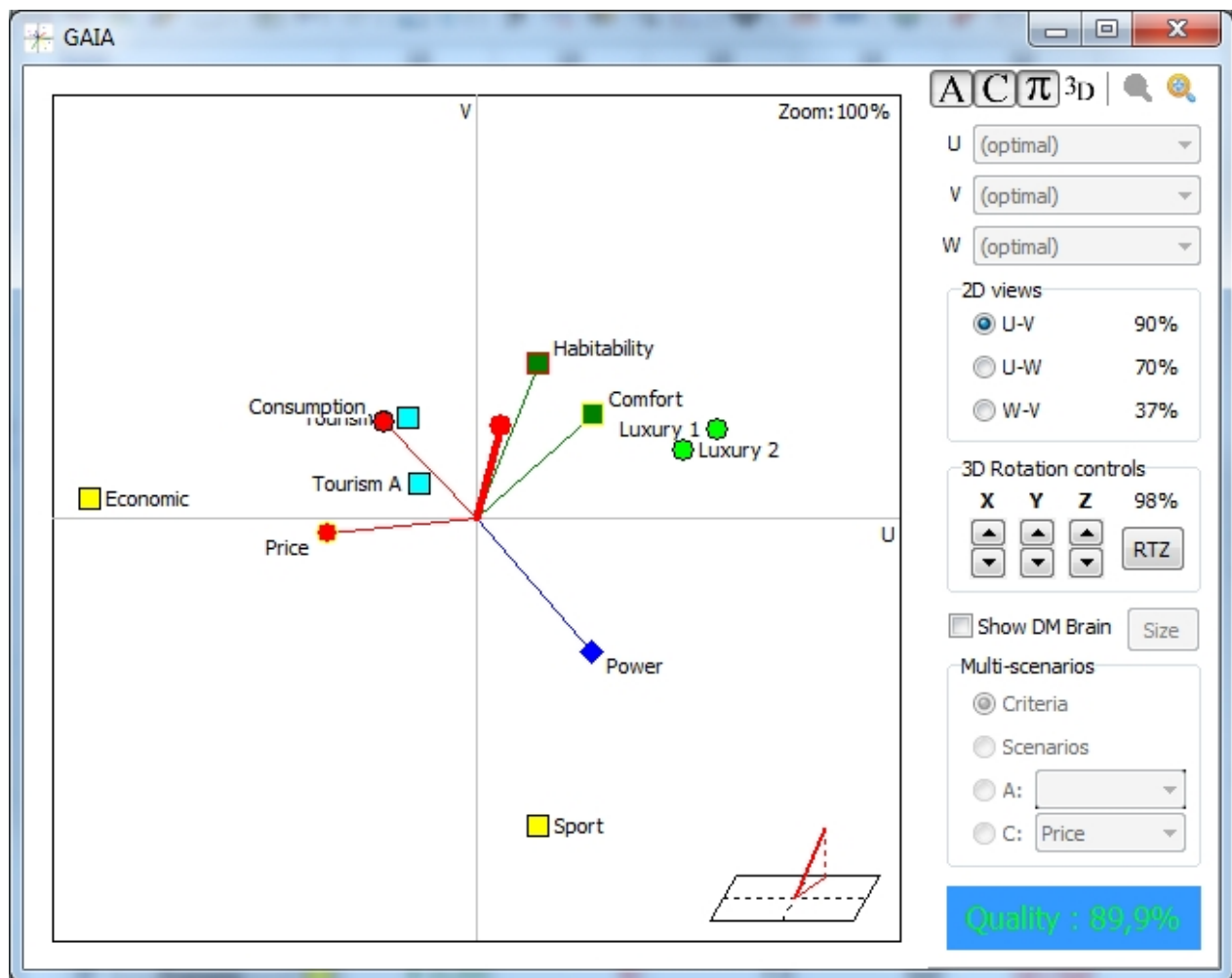
- Copy: Make a copy of the window to the clipboard. You will be able to paste it into another application such as e.g. Word, Excel or PowerPoint.
- Shortnames: You can choose to display the actions and/or criteria full names or short-names.
- Zoom: You can zoom in or out to focus on some part of the **GAIA** plane.
- Show stick: You can select whether and where you want the 3D view of the Decision Stick displayed.
- Show axis: You can select a criterion to display the projections of the actions on its axis, in order to check the actions performance on that criterion.
- Locate: You can select an action that will be highlighted on the display. That makes it easier to locate a particular action, especially when the number of actions is larger.

GAIA

The **GAIA** window has a lot of options. On the right side you can find the following options:

- The top tool bar includes six buttons:
 - A: controls the display of the actions on the **GAIA** plane.
 - C: controls the display of the criteria on the **GAIA** plane.
 - PI: controls the display of the decision axis on the **GAIA** plane.
 - 3D: switches between 2D and 3D views.
 - Zoom in.
 - Zoom out.
- The u,v,w drop-down lists: control the displayed axes. (This is currently NOT operational)
- The 2D views check-boxes:
- The 3D controls can be used to change the orientation of the 3D display.
- The "Show DM Brain" check-box toggles the **PROMETHEE VI** display of the **Decision-Maker Brain**. The "Size" button is used to control the weight variations.
- The Multi-Scenarios buttons can be used to activate the **GAIA GDSS** features.

At the bottom right of the window, the percentage of information retained in the **GAIA** display is shown. A color code is used: green indicates a satisfying quality level while red corresponds to a too low level.



Decision Maker Brain

What is it?

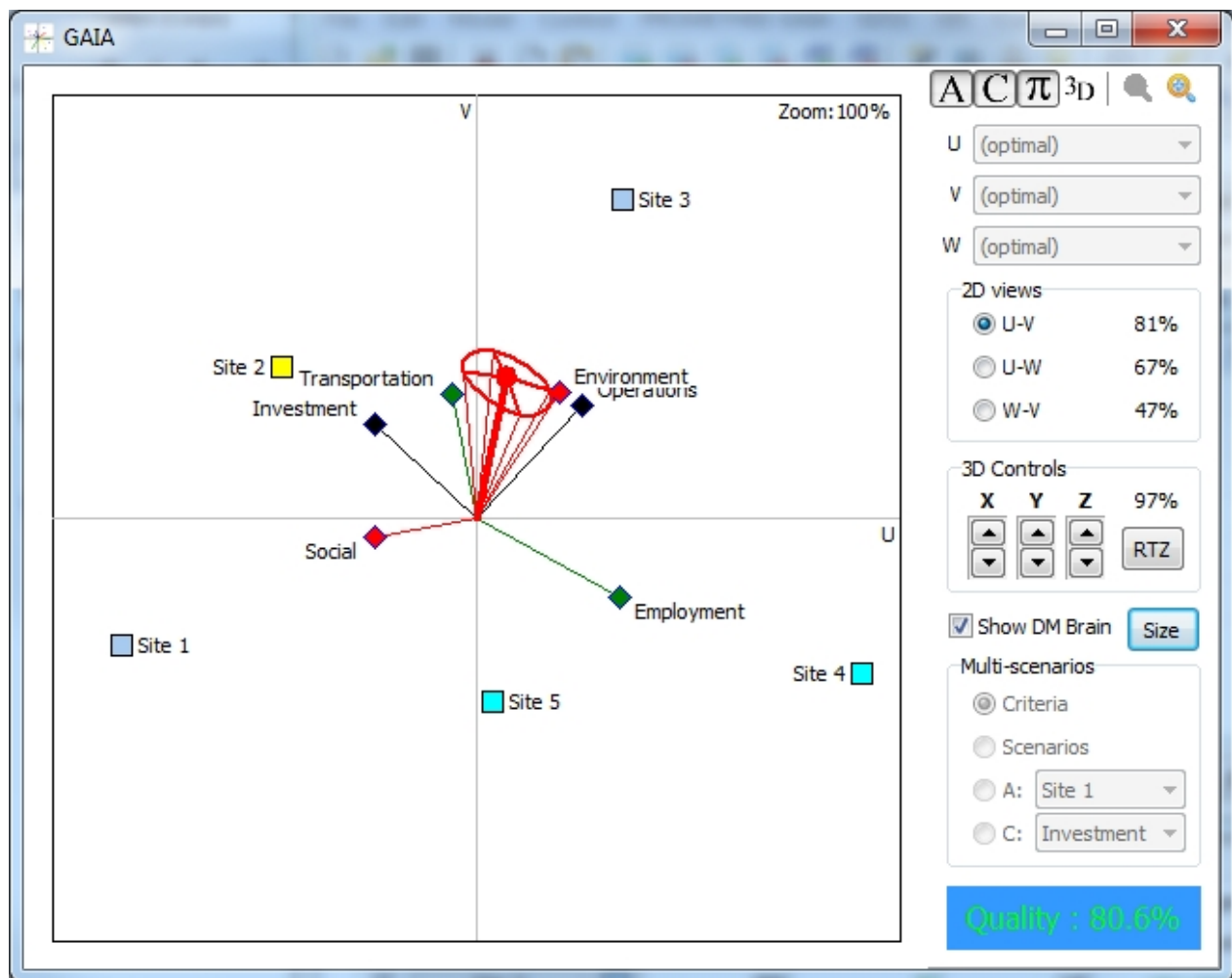
The **Decision Maker Brain** window allows to control the freedom level of the criteria in the [PROMETHEE VI](#) analysis.

How to interact?

- The "+" and "-" buttons can be used to modify the freedom level separately for each criterion.
- The four buttons at the bottom of the window allow to set all the freedom levels to one of four preset values: 10%, 25%, 50% or 75%.

Decision Maker Brain

The **Decision Maker Brain** window is accessed by clicking on the "Size" button at the right side of the **GAIA** window. This button is active only when the **Decision Maker Brain** is displayed as in the following screenshot.



The window displays:

- The freedom level for each criterion, expressed as a percentage.
- The corresponding minimum, current and maximum percentage weights of the criteria in the **PROMETHEE VI** analysis.

Decision Maker Brain						
	-	Freedom	+	min	current	max
Price	<input checked="" type="checkbox"/>	20%	<input type="checkbox"/>	16%	20%	24%
Power	<input type="checkbox"/>	20%	<input type="checkbox"/>	16%	20%	24%
Consumption	<input type="checkbox"/>	20%	<input type="checkbox"/>	16%	20%	24%
Habitability	<input type="checkbox"/>	20%	<input type="checkbox"/>	16%	20%	24%
Comfort	<input type="checkbox"/>	20%	<input type="checkbox"/>	16%	20%	24%

10% 25% 50% 75%

Action Profiles

What is it?

The **Action Profile** window displays the profile of one action. Up to five separate **Action Profile** windows can be opened to compare profiles.

How to interact?

There is a drop-down list to select the action you want to see. The "Phi" checkbox controls whether the multicriteria net flow value is displayed or not.

There is also a local menu. Right-click on the drawing to open it.

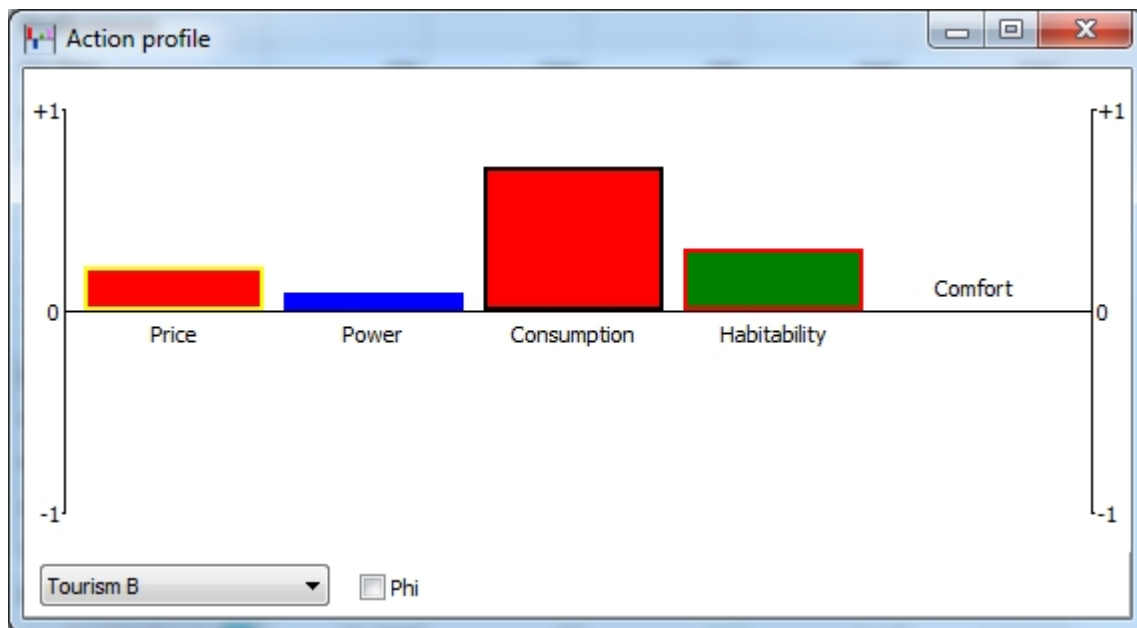
Local Menu

From the local menu the following options are available:

- Copy: Make a copy of the window to the clipboard. You will be able to paste it into another application such as e.g. Word, Excel or PowerPoint.

Action Profile

The **Action Profile** window shows a graphical representation of the unicriterion net flow scores for the selected action.



Positive scores (upward bars) correspond to good features while negative scores (downward bars) correspond to bad ones.

In the example above, there are no bad features and **Consumption** is very good.

GAIA Webs

What is it?

The **GAIA Web** window displays an enhanced spiderweb display for one action. Up to five separate **GAIA Web** windows can be opened to compare different actions.

How to interact?

There is a drop-down list to select the action you want to see.

The "Decision Axis" checkbox controls whether the decision axis and the multicriteria net flow value are displayed or not.

The "Rounded" checkbox can be used to generate a "rounded" version of the **GAIA Web**.

There is also a local menu. Right-click on the drawing to open it.

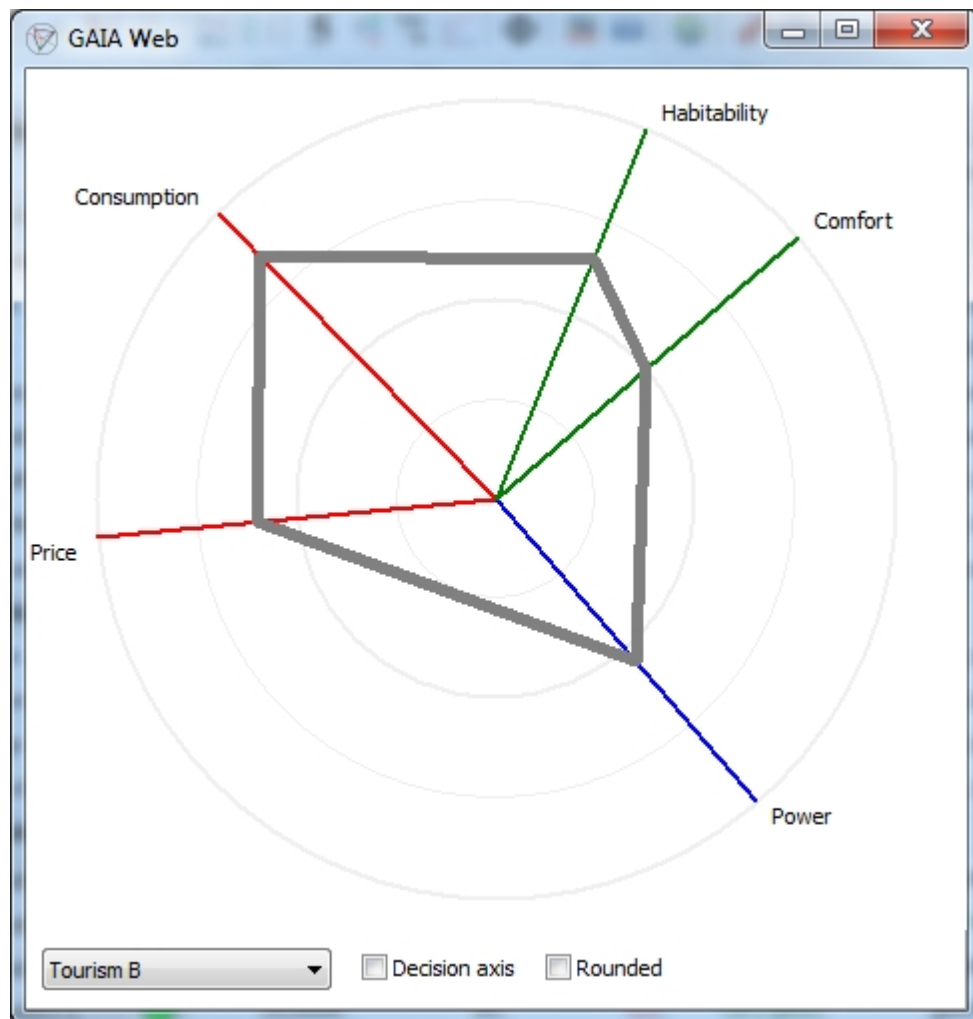
Local Menu

From the local menu the following options are available:

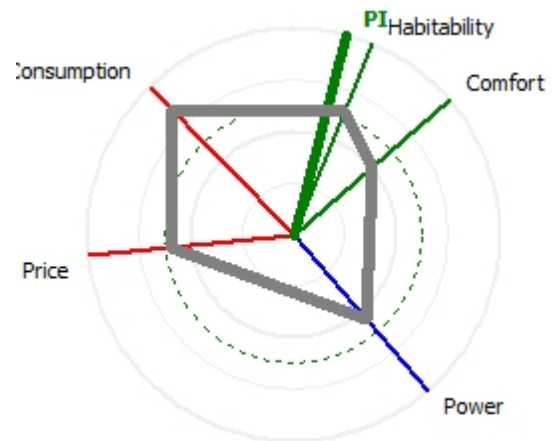
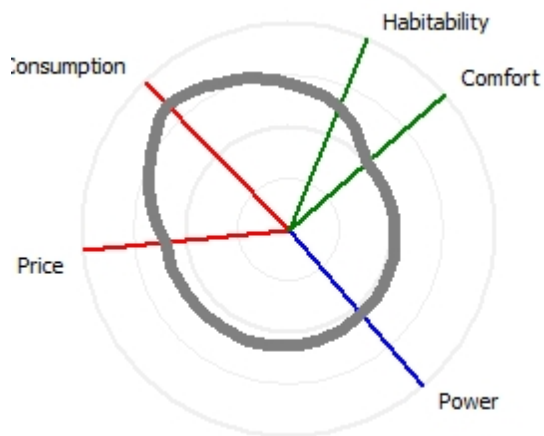
- Copy: Make a copy of the window to the clipboard. You will be able to paste it into another application such as e.g. Word, Excel or PowerPoint.
- Name: Either full or short names or no names can be displayed.

GAIA Web

The **GAIA Web** window shows a graphical representation of the [unicriterion net flow](#) scores for the selected action.



In usual spiderweb displays the variables (criteria) are equally spaced around the center of the display. The shape of the spiderweb is thus highly dependent on the arbitrary order of the criteria. In a **GAIA Web**, criteria axes are oriented as in the **GAIA** plane. Thus criteria expressing similar preferences are located close to each other and the spiderweb shape is more meaningful. For each dimension (individual criterion or grouped criteria group or cluster), the radial distance corresponds to the net flow score (-1 at the center and +1 on the outer circle).



The "Rounded" option replaces the straight lines that are drawn between axes by curves, allowing for a smoother and more consistent shape. For instance an action with equal scores on all dimensions would be represented as a circle instead of as a polygon.

The "Decision Axis" option shows the location of the Decision Axis as well as a dotted circle corresponding to the multicriteria net flow score of the actions (drawn in green if Phi is positive and in red if it is negative).

In the example above, there are no bad features and **Consumption** is very good. It is even clearer to see with the rounded option.

Walking Weights

What is it?

The Walking Weights let you easily change the weights of the criteria and check the impact on the analysis.

How to interact?

There is a drop-down list to select the criterion you want to control.

The padlock button is used to lock the percentage weight of the currently selected criterion.

The "Update" button is used to update the initial weights of the criteria with the current values.

The "Best to worst" button is used to rank the actions in the upper part of the window according to the **PROMETHEE II** Ranking.

The "Set equal" button is used to set all weights equal.

The "Reset" button is used to reset the weights to their initial values.

There is also a local menu. Right-click on the drawing to open it.

Local Menu

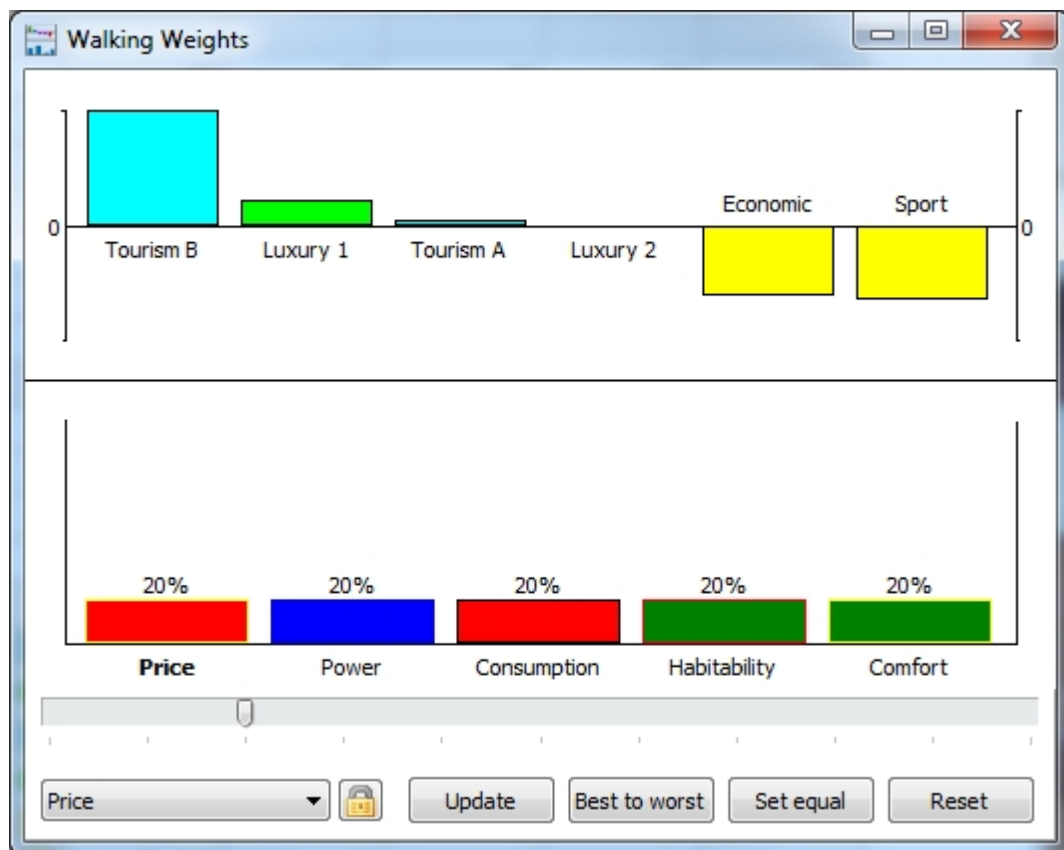
From the local menu the following options are available:

- Copy: Make a copy of the window to the clipboard. You will be able to paste it into another application such as e.g. Word, Excel or PowerPoint.
- Shortnames: To display full or short names for actions and/or criteria.

Walking Weights

The Walking Weights window contains two graphics:

- The upper part shows the **PROMETHEE II** Phi net flow scores for the active actions.
- The lower part shows the relative (percent) weights of the criteria (or grouped criteria groups or clusters).



Click on a criterion bar or use the bottom left drop-down list to select a criterion (or grouped group or cluster) and use the slider to change its weight. The change is reflected in the other opened windows.

Click on the padlock icon to lock the percentage weight of the selected criterion (a padlock icon is then displayed on top of the bar). Click again to unlock the weight. In the screenshot below, the weight of **Power** is locked to 20%.



Visual Stability Intervals

What is it?

The Visual Stability Intervals window let you easily change the weights of the criteria and check the impact on the analysis.

How to interact?

There is a drop-down list to select the criterion you want to visualize.

The "Stability level" check box controls the display of the weight stability interval. The level can be adjusted from 1 to the total number of active actions.

There is also a local menu. Right-click on the drawing to open it.

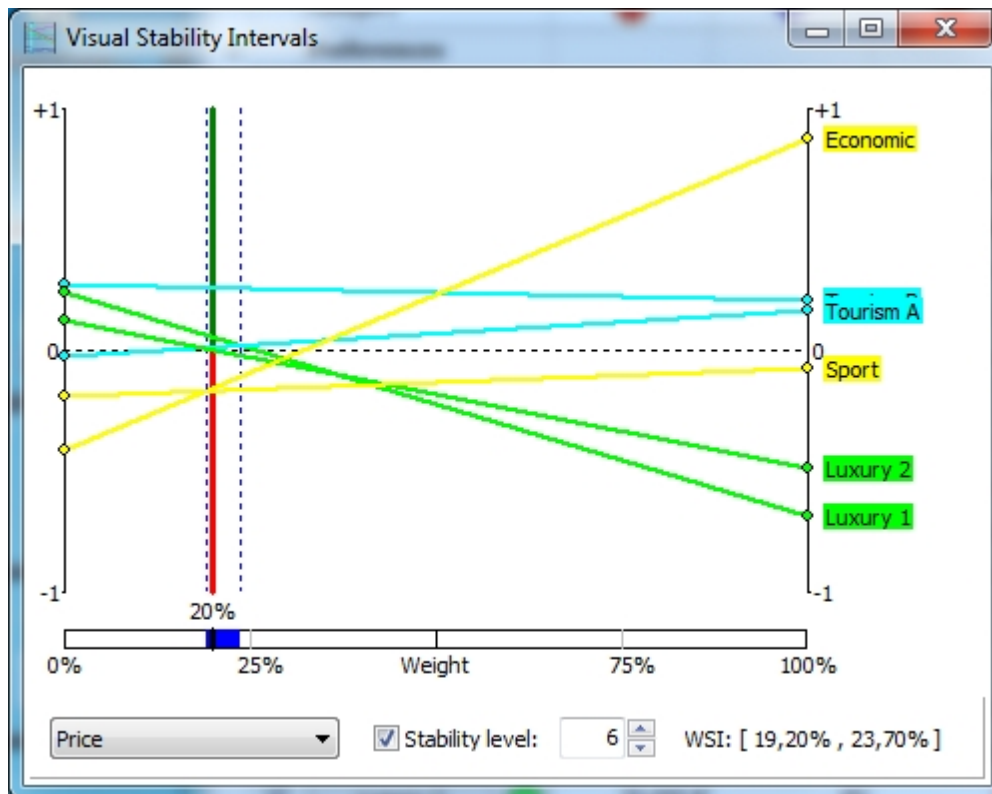
Local Menu

From the local menu the following options are available:

- Copy: Make a copy of the window to the clipboard. You will be able to paste it into another application such as e.g. Word, Excel or PowerPoint.
- Shortnames: To display full or short names for the actions.
- Locate: Select an action that will be highlighted on the display.

Visual Stability Interval

The **Visual Stability Intervals** window shows how the Phi multicriteria net flow scores change as a function of the weight of a criterion.



The horizontal dimension corresponds to the weight of the selected criterion. And the vertical dimension corresponds to the Phi net flow score. For each action a line is drawn that shows the net flow score as a function of the weight of the criterion. At the right edge of the display the weight of the criterion is equal to 100% and the actions are ranked according to that single criterion. At the left edge, the weight of the criterion is equal to 0%.

The position of the vertical green and red bar corresponds to the current weight of the criterion. The intersection of the action lines with the vertical bar gives the **PROMETHEE II** complete ranking.

On the example above, one can see that the scores of the **Luxury 1** and **2** cars go down when the weight of the **Price** criterion increases (they are indeed expensive) while the score of the **Economic** car increases (it is the cheapest one).

When the "Stability level" check box is checked, two dotted vertical lines are drawn to show the weight interval within which the top of the **PROMETHEE II** complete ranking remains unchanged (WSI - weight stability interval). The number of actions taken into account (stability level) can be set from 1 (top ranked action only) to the number of active actions (full ranking).

PROMETHEE V Selection

What is it?

PROMETHEE V uses the net flow computation to optimize the selection of a subset of actions under constraints such as maximum budget, location, etc.

How to interact?

There are two tabs in this window:

- Constraints:
To setup the selection constraints.
- Solution:
To view the optimal selection and perform what-if analyses.

PROMETHEE V

The [PROMETHEE V](#) method is used to select a best subset of actions according to several user-defined

constraints. It is based on a 0-1 linear program where the objective function is to maximize the sum of the net flow (Phi) scores of the selected actions.

Constraints

The top of the window includes two fields to set the minimum and maximum number of actions that should be selected. The two buttons allow to add or delete constraints in the bottom table.

For each constraint, it is possible to enter the coefficients, to specify the type of constraint (\leq , $=$ or \geq), to enter the right hand side, to specify the name and additional information (by clicking the button), and to activate or deactivate the constraint.

In the above example, one single "Budget" constraint has been added. Budget values (the prices of the cars, expressed in k€) have been entered for the different actions and the maximum budget is set to 55 k€. The number of cars to select is set to 2.

Solution

When this tab is selected, a branch and bound algorithm is started to find the optimal solution of the 0-1 linear program.

The left table shows the optimal solution that was found. The actions are displayed in the **PROMETHEE II** rank from top to bottom. The "Optimal" column displays the optimal solution. The buttons in the "Compare" column can be used to change the selection for comparison and make what-if analyses. The "Total" row shows the value of the objective function (i.e. the sum of the net flow scores of the selected actions) for both selections.

The right table shows the left and right hand sides of the constraints for both the optimal and the compared selections. Constraint violations appear in red.

Cars	Net Flow	Optimal	Compare
Total:		0,2707	0,3120
Tourism B	0,2573	Yes	Yes
Luxury 1	0,0547	No	Yes
Tourism A	0,0133	Yes	No
Luxury 2	-0,0013	No	No
Economic	-0,1573	No	No
Sport	-0,1667	No	No

Constraints	Optimal		Compare	
	LHS	RHS	LHS	RHS
Minimum	2,00	\geq 2,00	2,00	\geq 2,00
Maximum	2,00	\leq 2,00	2,00	\leq 2,00
Budget	51,50	\leq 55,00	63,50	\leq 55,00

In the above example, **PROMETHEE V** proposes to select the **Tourism B** (1st ranked in **PROMETHEE II**) and **Tourism A** (3rd ranked) cars for a total flow of 0,2707. It doesn't select the second best action (**Luxury 1**) as this would violate the "Budget" constraint. This can be checked in the "Compare" columns: the total flow is higher (0,3120) but the budget is too large (63,5 k€).

PROMETHEE Sort

What is it?

PROMETHEE Sort is an extension of **PROMETHEE** for sorting [actions](#) in predefined [classes](#).

How to interact?

There are four tabs in this window:

- Class Setup:
To setup the classes and the sorting parameters.
- Actions Setup:
To select which actions have to be sorted.
- Sort Result:
To view the class assignment.
- Visual Sort:
To graphically visualize the sort result for ordered classes and boundary profiles.

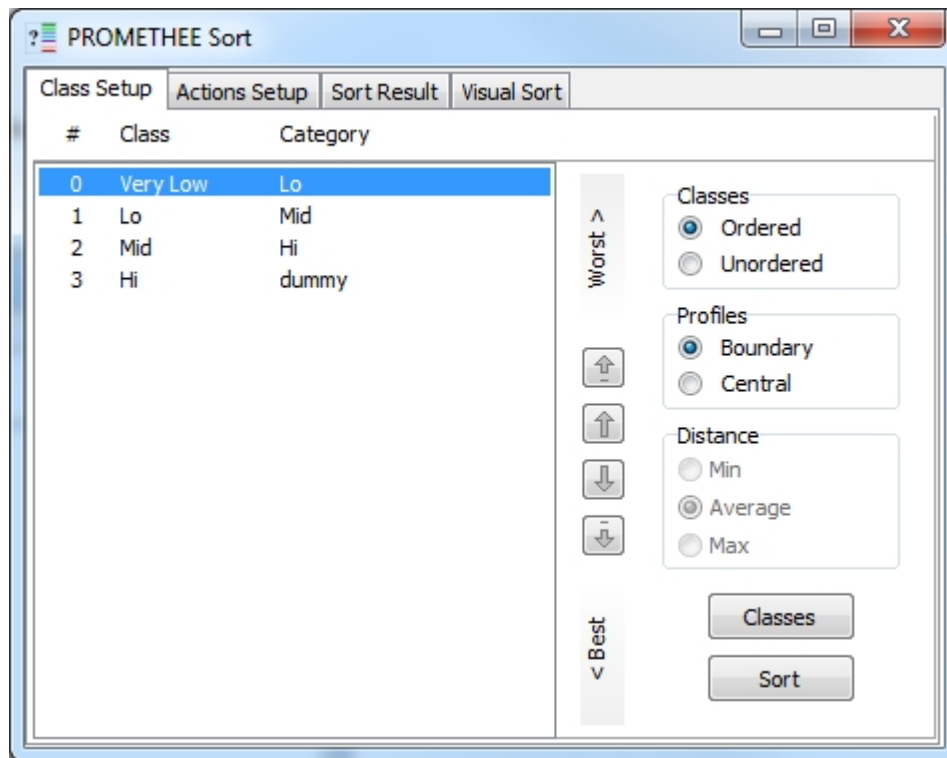
PROMETHEE Sort

The **PROMETHEE Sort** method can be used in different contexts where the [actions](#) have to be allocated to a set of predefined [classes](#):

- The classes can be ordered from the least preferred to the most preferred one (e.g. to represent different levels of risk from "very high" to "very low") or they can be unordered (e.g. to establish a taxonomy of consumers based on different consuming behaviors).
- Each class is identified by one or several reference [profiles](#). In **Visual PROMETHEE** the profiles should belong to an [action category](#) that is linked to the class. The reference profiles can be either:
 - boundary profiles: this can be used only with ordered classes. In **Visual PROMETHEE**, each class has a upper boundary profile (the upper boundary profile of the most preferred class is not used).
 - central profiles: this is the only possible option for unordered classes.

Class Setup

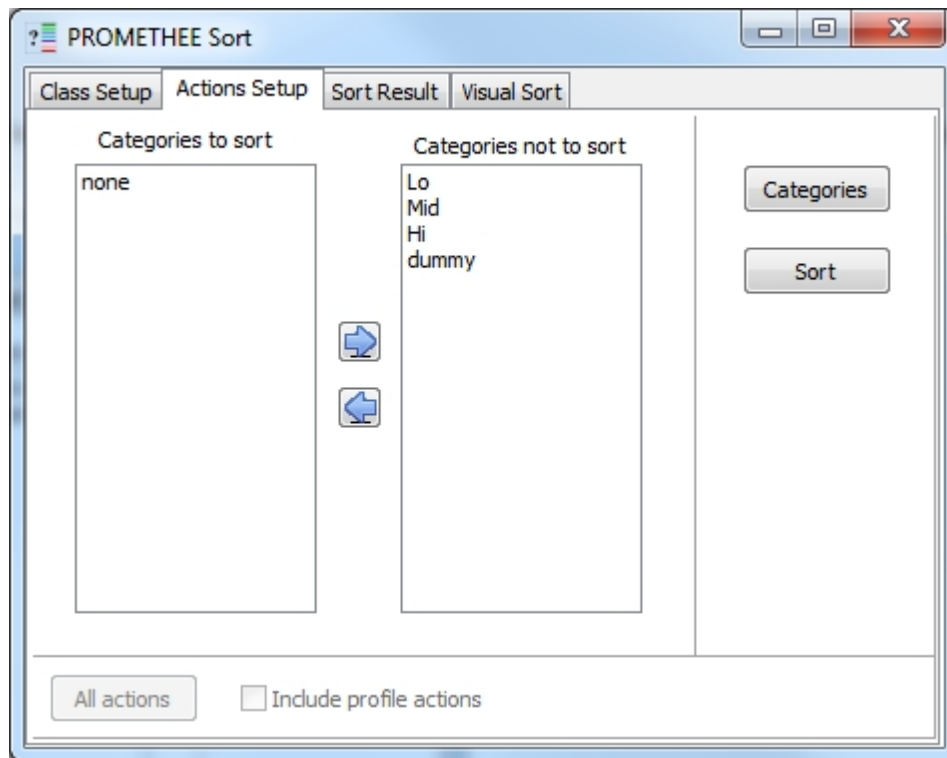
The left part of the window displays the list of the existing classes. The right part contains several commands that can be used to control the sorting method.



- The **Classes** radio buttons allow to choose either ordered or unordered classes.
- The **Profiles** radio buttons allow to use either boundary (ordered classes only) or central profiles.
- The **Distance** radio buttons allow to select the distance measurement used by the sort algorithm with central profiles.
- The middle arrow buttons allow to change the order of the classes. In the case of ordered classes, the least preferred (worst) class should be at the top and the most preferred (best) class at the bottom of the list.
- The **Classes** button opens the [Classes](#) dialog from which classes can added or edited.
- The **Sort** button starts the computation and displays the results.

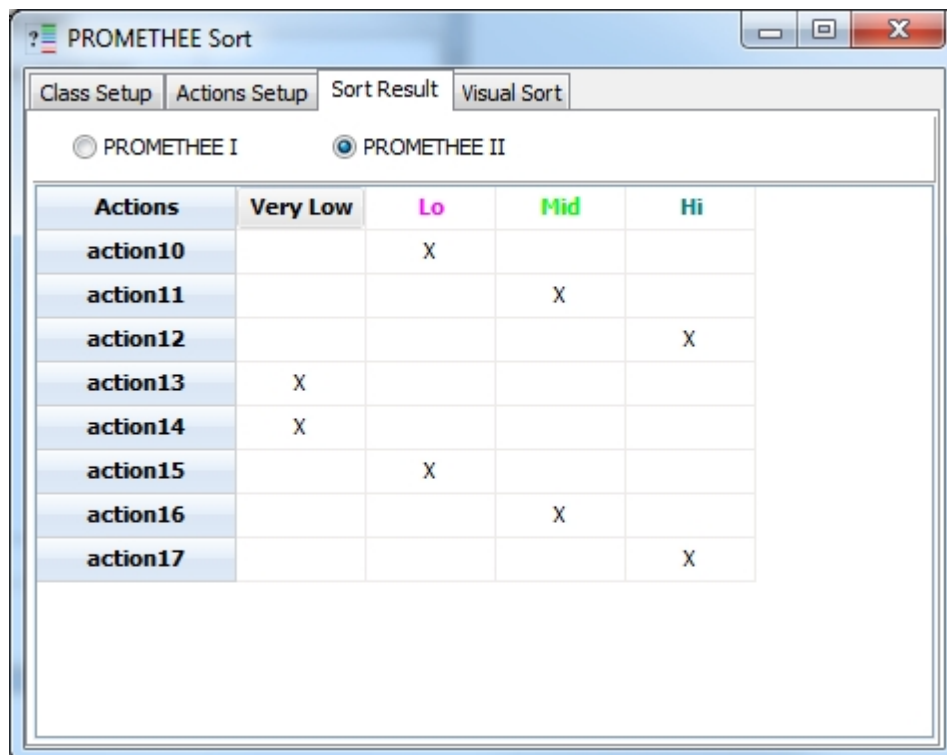
Actions Setup

The main part of the window displays two list boxes of action categories: to the left are the categories that have to be sorted, to the right those that don't have to be sorted (usually the profile categories). The arrow buttons can be used to move categories from one list to the other.



- The **Categories** button opens the [Categories](#) dialog from which categories can added or edited.
- The **Sort** button starts the computation and displays the results.
- The **All actions** button set all the categories to be sorted, including the profile categories if the checkbox "**Include profile actions**" is checked.

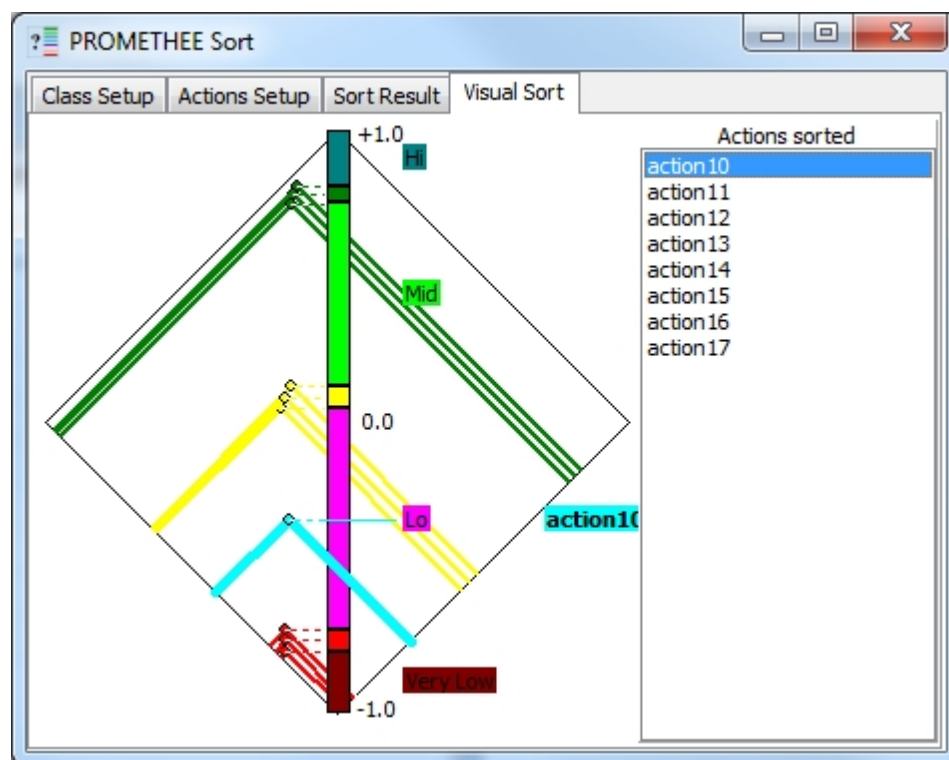
Sort Result



Visual Sort

Visual Sort is available for ordered classes and boundary profiles only. It shows a [PROMETHEE Diamond-](#)

like view of an action compared to the class profiles.



Bank Adviser

What is it?

[Bank Adviser](#) is an extension of **PROMETHEE** designed for evaluating [actions](#) with respect to a [reference set](#).

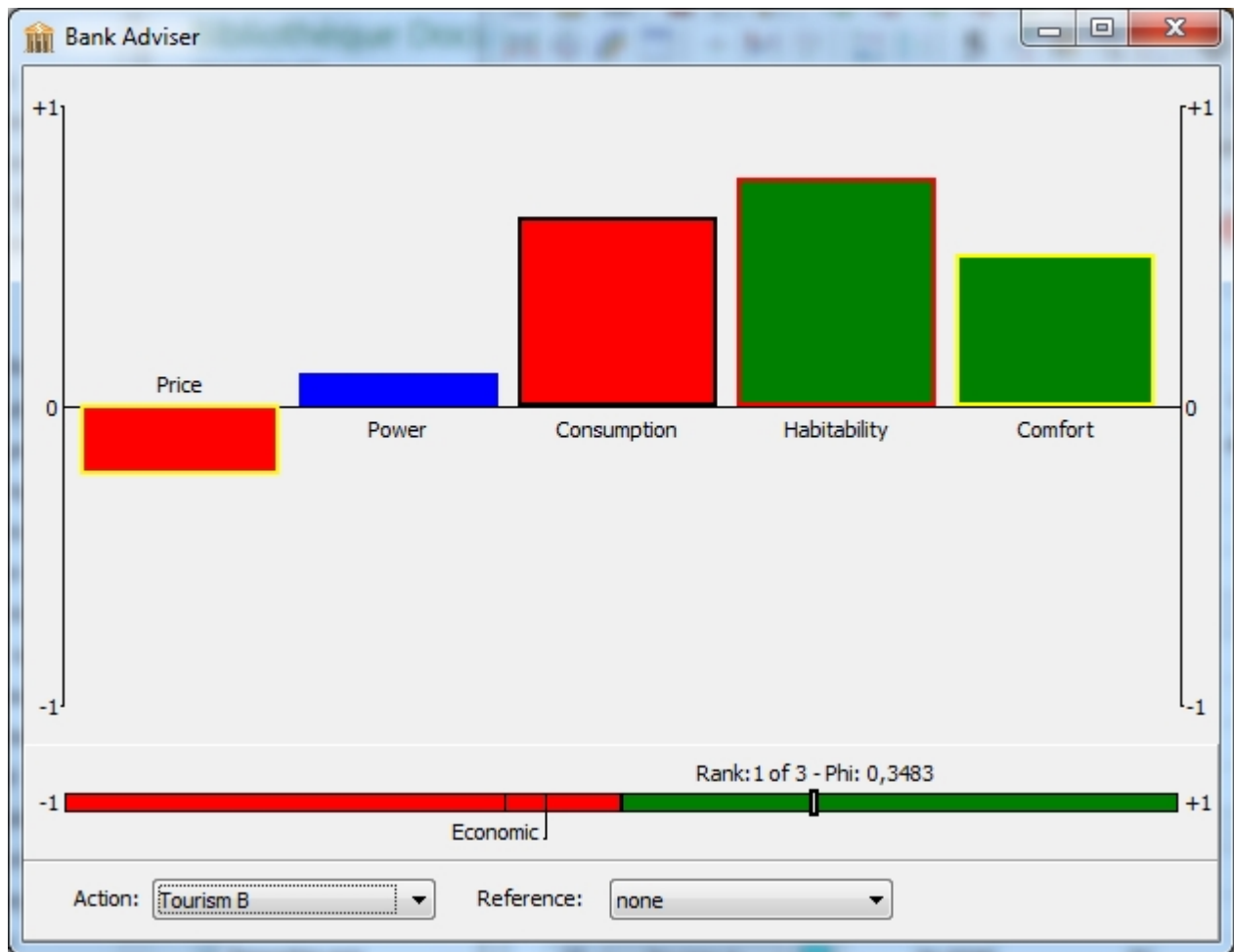
How to interact?

There is a drop-down list to select the action you want to evaluate.
There is also a drop-down list to select the reference set of actions.
There is also a local menu. Right-click on the drawing to open it.

Bank Adviser

The [Bank Adviser](#) analysis allows to evaluate an action with respect to a reference set of actions. The reference set can be for instance:

- a set of well-known actions,
- a subset of actions (for instance geographically defined),
- a set of reference points (fictive actions),
- a peer-group.



In **Visual PROMETHEE** the reference set has to be a [category](#) of [actions](#).

The **Bank Adviser** window contains two areas:

- At the top is the action profile:
This is the profile of the selected action compared only to the reference set actions. It is thus different from the [Action Profile](#) window where all actions are compared to each other.
- At the bottom is the ruler:
The ruler shows the Phi scale (from -1.0 to + 1.0) and the positions of the selected action (wide cursor with the Phi value and the rank of the action indicated on top of it) and of the reference actions (thinner bars, with the closest reference actions indicated below the ruler).

Performance Analysis

What is it?

This section introduces an extension of the **PROMETHEE** method for the evaluation of the relative performance of a set of units, according to several input and output criteria.

It is still in a research development phase and is intended as an alternative to methods such as Data Envelopment Analysis (DEA).

The actions correspond to the units to evaluate and two clusters of criteria have to be defined: all input criteria should be in a single cluster, and all output criteria should be in another single cluster.

Performance Analysis

There are two types of analyses that are available:

- Aggregated score

- I-O Efficiency

Aggregated Score

The table displays for each action:

- Input: The net flow computed for the input cluster of criteria.
- Output: The net flow computed for the output cluster of criteria.
- O/I ratio: A performance measurement computed as a ratio between normalized output and input flows.
- Score: A percentage score corresponding to the O/I ratio: the best performing action has a 100,00 score.

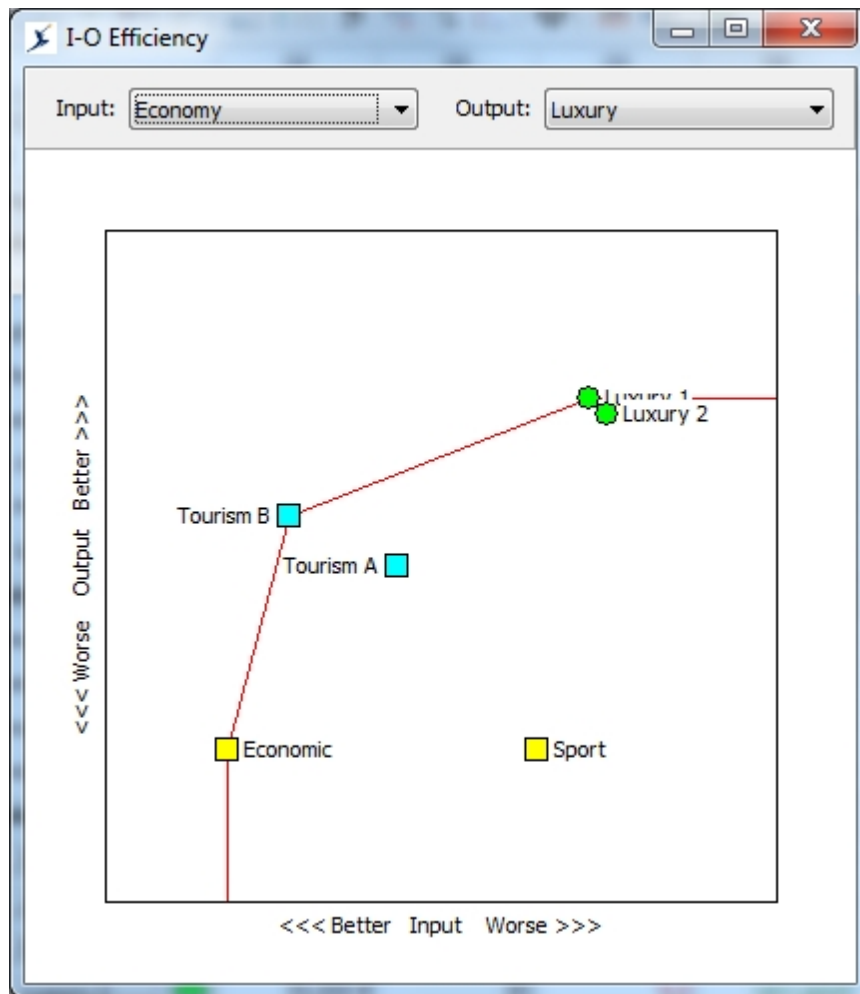
	Input	Output	O/I ratio	Score
Tourism B	0,4533	0,1500	2,1037	100,00
Luxury 1	-0,4433	0,5000	1,0393	49,40
Tourism A	0,1333	0,0000	1,1538	54,85
Luxury 2	-0,4933	0,4500	0,9710	46,16
Economic	0,6367	-0,5500	1,2385	58,88
Sport	-0,2867	-0,5500	0,3497	16,63

The example above is not very realistic and is just introduced for demonstration purpose: Economy (**Price** and **Consumption**) criteria are considered as the input and Luxury (**Habitability** and **Comfort**) criteria are considered as the output. (**Power** is thus not taken into account here.)

I-O Efficiency

This is a two-dimensional representation of the Input and Output flows.

An "efficiency" frontier is drawn in red.



In the example above, three actions are on the efficient frontier with quite different performance profiles:

- **Economic:** lower input use but lower output as well,
- **Luxury 1:** high input use but higher output as well,
- **Tourism B:** more average input and output levels.

It is difficult to compare those three actions with respect to I/O performance.

The other three actions lag behind the efficient frontier. Their performance could be improved comparatively to the "efficient" actions.

Preference Flows

What is it?

The Preference Flows window displays the **PROMETHEE** unicriterion and multicriteria preference flows in a tabular format.

How to interact?

There are two tabs in this window:

- Unicriterion: The unicriterion net flows are displayed.
- Multicriteria: The multicriteria positive, negative and net flows are displayed.

There is also a local menu. Right-click on the drawing to open it.

Local Menu

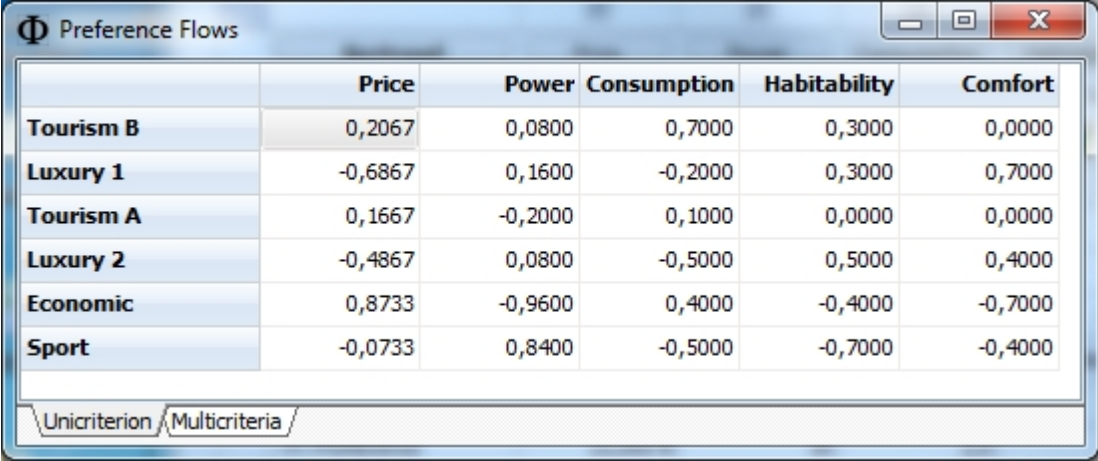
From the local menu the following options are available:

- Copy: Make a copy of the window to the clipboard. You will be able to paste it into another application such as e.g. Word, Excel or PowerPoint.

Preference Flows

Unicriterion

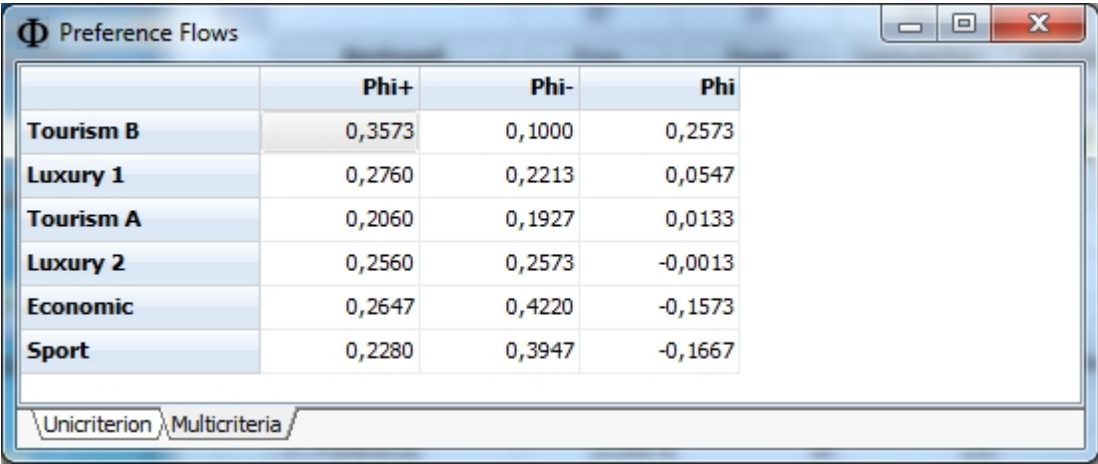
The unicriterion net flows are displayed for each criterion (or grouped group or cluster).



	Price	Power	Consumption	Habitability	Comfort
Tourism B	0,2067	0,0800	0,7000	0,3000	0,0000
Luxury 1	-0,6867	0,1600	-0,2000	0,3000	0,7000
Tourism A	0,1667	-0,2000	0,1000	0,0000	0,0000
Luxury 2	-0,4867	0,0800	-0,5000	0,5000	0,4000
Economic	0,8733	-0,9600	0,4000	-0,4000	-0,7000
Sport	-0,0733	0,8400	-0,5000	-0,7000	-0,4000

Multicriteria

The multicriteria positive (Phi+), negative (Phi-) and net (Phi) flows are displayed.



	Phi+	Phi-	Phi
Tourism B	0,3573	0,1000	0,2573
Luxury 1	0,2760	0,2213	0,0547
Tourism A	0,2060	0,1927	0,0133
Luxury 2	0,2560	0,2573	-0,0013
Economic	0,2647	0,4220	-0,1573
Sport	0,2280	0,3947	-0,1667

Scenarios Comparison

What is it?

The PROMETHEE Rankings window displays the **PROMETHEE I** and **II** rankings in two separate tabs.

How to interact?

There are two tabs at the bottom of the window:

- Pairwise: For comparing two scenarios side by side.
- All scenarios: To compare all the scenarios together.

There is also a local menu. Right-click on the drawing to open it.

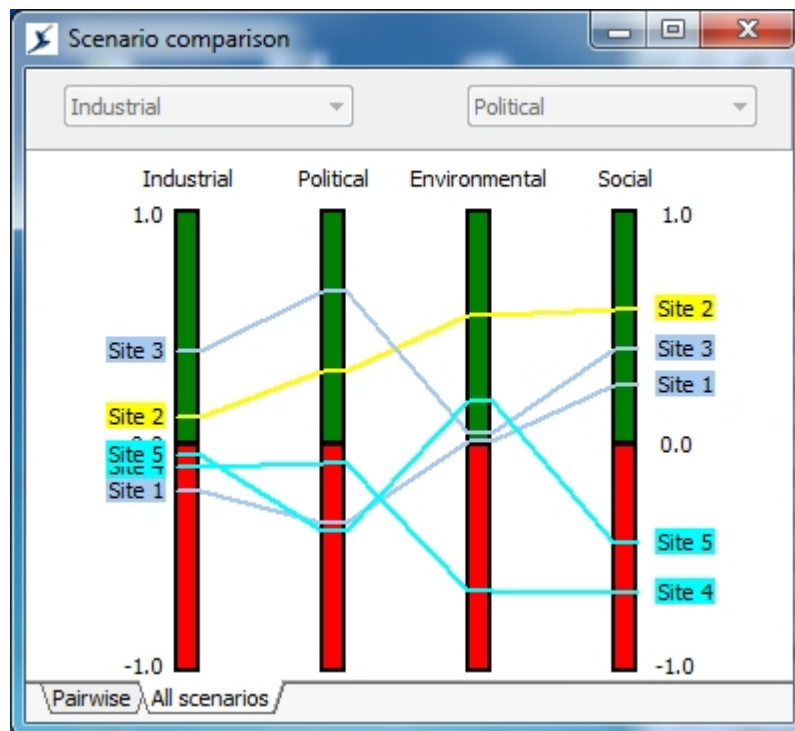
Local Menu

From the local menu the following options are available:

- Copy: Make a copy of the window to the clipboard. You will be able to paste it into another application such as e.g. Word, Excel or PowerPoint.
- Locate: You can select an action that will be highlighted on the display. That makes it easier to locate a particular action, especially when the number of actions is larger.

Scenario Comparison

This window allows to compare the **PROMETHEE II** rankings obtained for several scenarios.



The above example shows the "All scenarios" tab: the **PROMETHEE II** ranking for each scenario is displayed on a vertical green-red bars and a line is drawn for each active action.

In the "Pairwise" tab, only two scenarios are displayed. The two drop-down list boxes located at the top of the window are used to select the scenarios to compare.

Balance of Power

What is it?

The Balance of Power let you easily change the weights of the scenarios and check the impact on the analysis.

How to interact?

There is a drop-down list to select the scenario you want to control.

The padlock button is used to lock the percentage weight of the currently selected criterion. **not implemented yet**

The "Update" button is used to update the initial weights of the scenarios with the current values. **not implemented yet**

The "Set equal" button is used to set all weights equal.

The "Reset" button is used to reset the weights to their initial values. **not implemented yet**

There is also a local menu. Right-click on the drawing to open it.

Local Menu

From the local menu the following options are available:

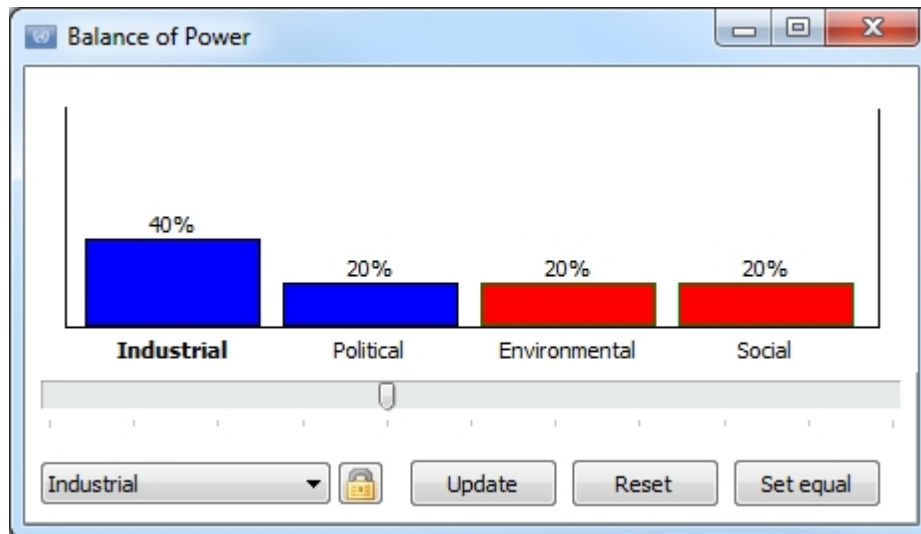
- Copy: Make a copy of the window to the clipboard. You will be able to paste it into another application

such as e.g. Word, Excel or PowerPoint.

- Shortnames: To display full or short names for the scenarios.

Balance of Power

The Balance of Power window contains the following information:



The bar chart shows the relative weights of the active [scenarios](#).

Use the drop-down list or click on a bar to select a scenario. Then use the slider to change the weight of the selected scenario.

Click "Set equal" to set equal weights for all the active scenarios.

PROMap

What is it?

PROMap provides **Visual PROMETHEE** with GIS features.

How to interact?

There are several controls available in this window:

- To the left and top right of the window are the usual Google Maps controls you can use to explore the map.
- At the bottom of the window are several controls:
 - Locate: Click this button to center the map on the selected action.
 - Display: Select the type of information to be displayed on the map.
 - Copy: Copy the map to the clipboard.
- Clicking on an action marker opens an information window.

PROMap

The **PROMap** display provides the integration of the **Visual PROMETHEE** analysis with Google Maps. To use it an active Internet connection is required.

Each action can be associated to a geographical location on the map. This can be done in the [Actions](#) dialog.

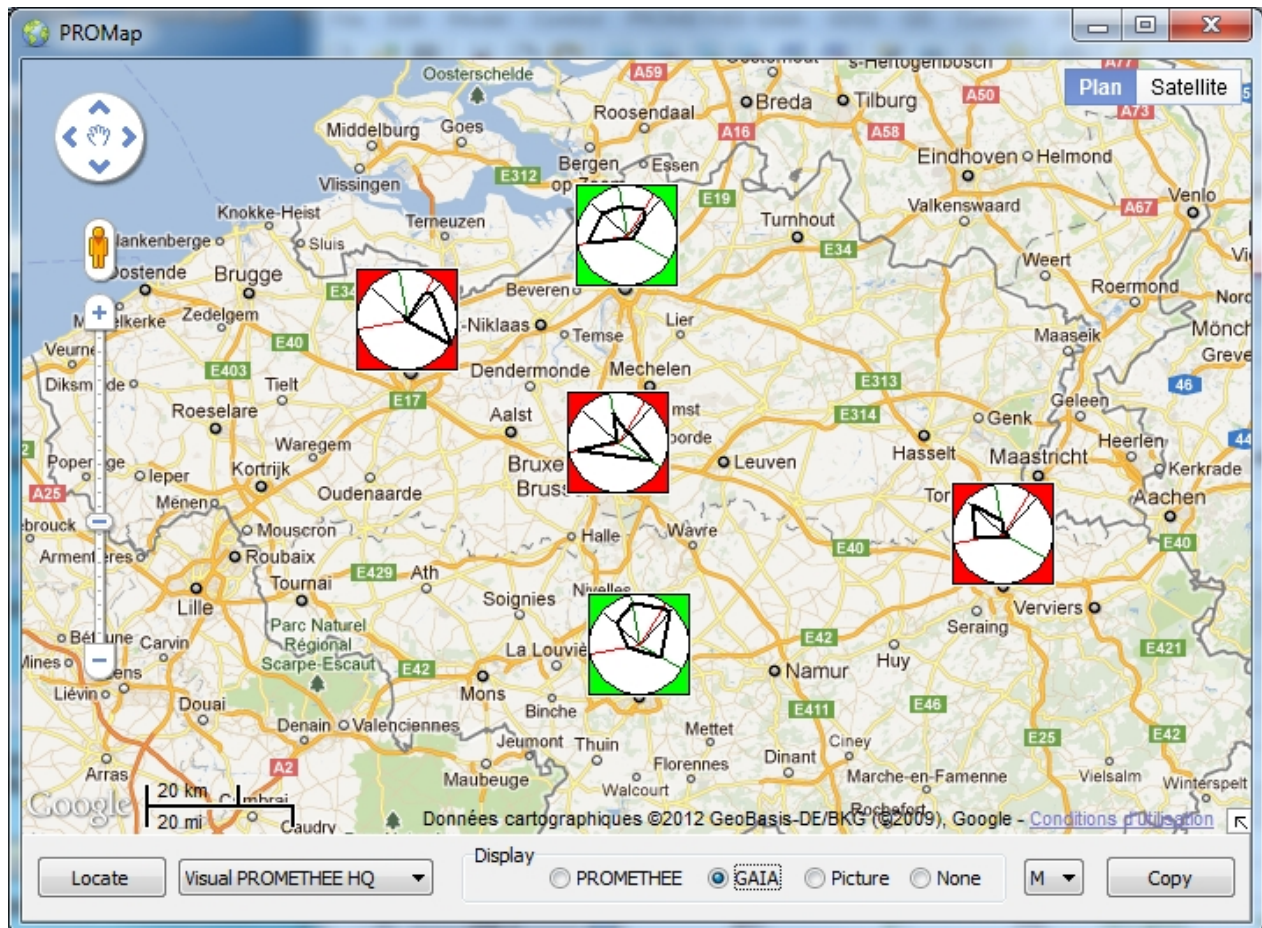
The results of the **PROMETHEE-GAIA** analysis can then be displayed in Google Maps. There are four possible displays:

- **PROMETHEE**: Actions are represented by squares. Positive flow scores are displayed in green and negative scores in red. The size of the square is increasing with the absolute value of the score. So,

best ranked actions correspond to large green squares and worst actions to large red squares.

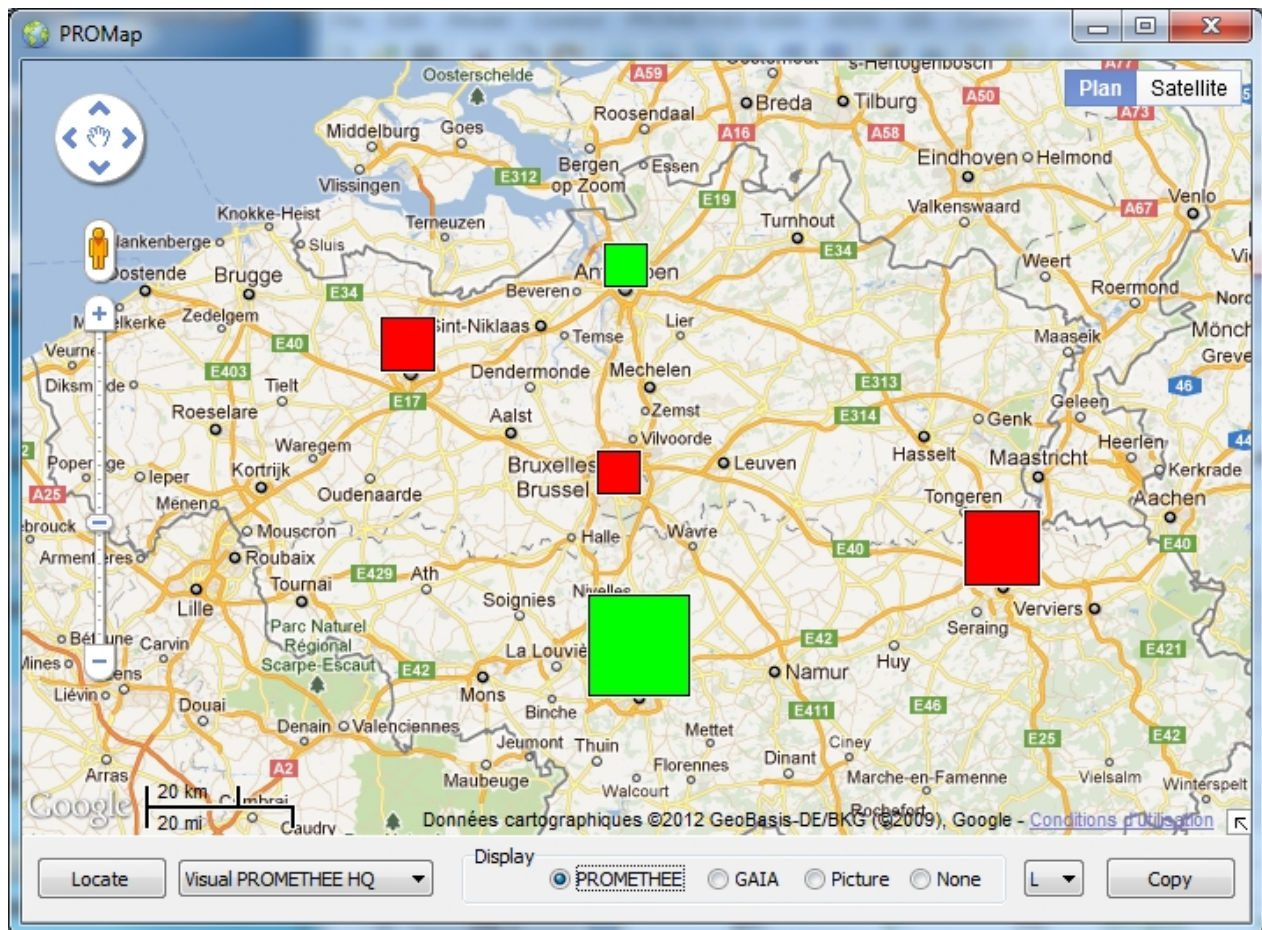
- **GAIA:** Miniature versions of the **GAIA Webs** are displayed with a green or red square outline according to whether the action's net flow score is positive or negative.
- Picture: The picture associated to the action is displayed.
- None: Standard Google Maps markers are displayed.

The size of the markers can be changed from S (small) to XL (extra-large) using the drop-down list box.



In the above example, **GAIA Webs** are displayed. Quite different profiles are visible.

In the second screen shot, the **PROMETHEE** ranking is represented by squares. The best action is located to the South while the worst one is located to the East.



Weight Presets

What is it?

Weight presets allow to save different sets of weights for easy comparison.

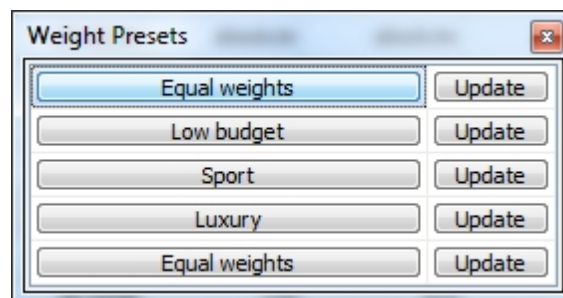
How to interact?

There are two columns of buttons in this small window:

- Clicking on a left column button loads the corresponding weight preset.
- Clicking on a right column button ("Update") allows to save the current weights to that preset and to change its name if necessary.

Weight Presets

Five different weight presets can be defined for a given data set. The presets are saved with the data.



When starting a new problem, the presets are automatically set to equal weights for all the criteria.

Layouts

What is it?

Layouts allow to save different windows configurations for different types of analyses and to switch easily from one layout to another.

How to interact?

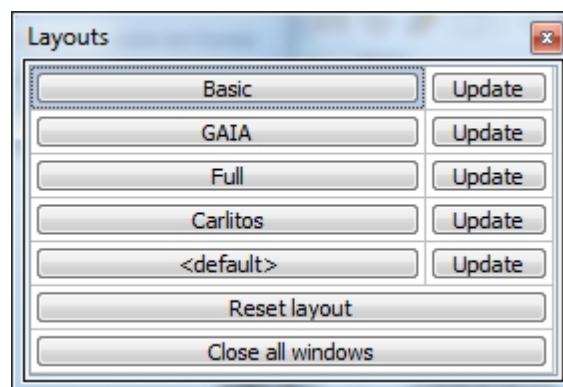
There are two columns of buttons in this small window:

- Clicking on a left column button switches the windows positions to the corresponding layout.
- Clicking on a right column button ("Update") allows to save the current layout to that row and to change its name if necessary.

The two buttons at the bottom of the window allow to reset the position of all the windows and to close all the windows.

Layouts

Five different layouts can be defined. The layouts are saved within the software and can be used with any data set. Each layout stores the position and state (visible, hidden, maximized) of the different windows.



PROMETHEE and GAIA methods

This chapter describes the methodology behind **Visual PROMETHEE**. It is organized as follows:

- A general introduction to **MCDA** concepts.
- The preference model used in the **PROMETHEE** and **GAIA** methods ([preference functions](#) and [weights](#)).
- The way the **PROMETHEE** rankings are computed.
- The **GAIA** descriptive analysis.
- And more advanced topics:
 - Sensitivity analyses.
 - **GDSS** extensions.
 - **PROMETHEE V** selection under constraints.
 - **PROMETHEE Sort**.
 - **Bank Adviser**.
 - Performance analysis using **PROMETHEE**.

Here is a more detailed table of contents:

- [MCDA](#)
 - [Multicriteria Table](#)
 - [Aggregation and Weighted Sum](#)
 - [Outranking Methods](#)
- [PROMETHEE Preference Model](#)
 - [Seven Requisites](#)
 - [Preference Functions](#)
 - [Criteria Weights](#)
 - [Pairwise Comparisons](#)
- [PROMETHEE Rankings](#)
 - [Preference Flows](#)
 - [PROMETHEE I Partial Ranking](#)
 - [PROMETHEE II Complete Ranking](#)
- [GAIA](#)
 - [Unicriterion Net Flows](#)
 - [GAIA Plane](#)
 - [GAIA 3D](#)
- [Sensitivity Analysis](#)
- [GDSS PROMETHEE](#)
 - [Multi-scenario Preference Flows](#)
 - [Consensus PROMETHEE Rankings](#)
 - [Multi-scenario GAIA](#)
- [PROMETHEE V Selection](#)
- [PROMETHEE Sort](#)
- [Bank Adviser](#)
- [Performance Analysis](#)

MCDA

MCDA stands for **MultiCriteria Decision Aid**. It includes many approaches, models and methods to handle decision or evaluation problems where multiple evaluation [criteria](#) have to be taken into account.

Indeed most decisions we make are not easy because they involve multiple and conflicting objectives. For instance:

- **Procurement:** which is the best supplier?
- **Key Performance Indicators:** how to evaluate performance of business units?
- **Portfolio Management:** how to compose the best R&D projects or financial assets portfolio?
- **Location:** what is the best place to build a new facility (plant, warehouse, hypermarket, ...)?
- **Health Care:** what is the best therapeutic choice to treat a patient?
- **Sustainable Development:** what is the best way to achieve sustainable development?

In each case, one or several persons ([decision-makers](#) or stakeholders) have to compare different solutions ([actions](#)) with several objectives in mind. For instance:

- **Procurement:** minimize the price paid, maximize the quality of the product purchased, maximize the quality of service supplied, ...
- **Key Performance Indicators:** minimize costs, maximize profit, maximize efficiency, ...
- **Portfolio Management:** minimize risk, maximize expected return, ...
- **Location:** minimize investment cost, maximize expected return, minimize environmental impacts, maximize safety, ...
- **Health Care:** maximize efficiency, minimize side effects, reduce costs, ...
- **Sustainable Development:** reduce environmental impacts, reduce social impacts, improve wealth.

The degree of achievement of these objectives can be measured by defining appropriate quantitative or qualitative evaluation [criteria](#) such as for instance:

- the price of an equipment (in € or in \$ or...),
- a qualitative measurement of social impact (on a scale such as: very low, low, moderate, high or very high),
- GHG emissions, ...

These criteria are usually conflicting with each other:

- Usually higher quality equipment is more expensive.
- Taking care of environmental issues can have a negative impact on profit.
- Building a new hypermarket closer to a big city will cost more money but will bring a higher level of expected return.
- ...

That's why most of our decisions are difficult to make. So what's best?

It depends. On your priorities. On your preferences.

MCDA methods are designed to assist decision-makers in such a context.

The **PROMETHEE** and **GAIA** methods can help you to answer the following questions and many others as well:

- "What is the best choice?"
The [PROMETHEE Rankings](#) will show you the best compromise solutions according to the evaluation criteria, your preferences and priorities.
- "Is this a good customer?"
The [PROMETHEE Sort](#) procedure will help you to allocate an item to a predefined class (such as for instance: good customers, average customers or bad customers).
- "Why is this not a good solution?"
The [GAIA](#) visual analysis will help you to understand better the decision problem, to see what is possible and what is not, to justify your choices or to acknowledge that some choices cannot be

justified. It will also help you to explain to other persons why some decisions are better.

- "Which projects should we support?"
[PROMETHEE V](#) will assist you in selecting different options according to constraints such as budget limit, incompatibilities, diversification, etc.
- "Why can't we agree on a common decision?"
The [GDSS](#) extensions of **PROMETHEE** and **GAIA** are available to help a group of persons to make a decision together.

The next sections of this chapter introduces basic concepts about multicriteria decision aid in the context of the use of the **PROMETHEE** and **GAIA** methods and of the **Visual PROMETHEE** software.

- [Multicriteria Table](#)
- [Aggregation and Weighted Sum](#)
- [Outranking Methods](#)

Multicriteria Table

The **PROMETHEE** methods are designed to analyze data within a multicriteria table including:

- a number of [actions](#),
- several [criteria](#).

In mathematical terms the problem is the following:

$$\max \{f_1(a), f_2(a), \dots, f_j(a), \dots, f_k(a) \mid a \in A\}$$

where A is a finite set of n actions and f_1 to f_k are k criteria. $f_j(a)$ is the evaluation of action a on criterion f_j . There is no objection to consider some criteria to be maximized and others to be minimized but for the sake of simplicity we will suppose here that all criteria have to be maximized.

The evaluations of the actions on the criteria form a two-way multicriteria table:

	f_1	f_2	...	f_j	...	f_k
a_1	$f_1(a_1)$	$f_2(a_1)$	...	$f_j(a_1)$	...	$f_k(a_1)$
a_2	$f_1(a_2)$	$f_2(a_2)$	...	$f_j(a_2)$	...	$f_k(a_2)$
\vdots	\vdots	\vdots		\vdots		\vdots
a_i	$f_1(a_i)$	$f_2(a_i)$	...	$f_j(a_i)$	...	$f_k(a_i)$
\vdots	\vdots	\vdots		\vdots		\vdots
a_n	$f_1(a_n)$	$f_2(a_n)$	...	$f_j(a_n)$	...	$f_k(a_n)$

The expectation of the [decision-maker](#) is to identify an action that is the best (optimal) on all the criteria at the same time.

That is usually impossible as the criteria are more or less conflicting with each other. The objective of **MCDA** is thus to identify the best compromise decisions.

In order to achieve this objective, it is essential to have some information about the preferences and the priorities of the decision-maker. This information is not contained in the multicriteria table. And different decision-makers will have different preferences and priorities.

Gathering information about the decision-maker preferences and priorities can be done in many different ways. In the next chapters we compare two common ways and we emphasize their qualities and their limits.

The **Visual PROMETHEE** demo is about a person who wants to purchase a new car. There are six cars to compare. These are the [actions](#). And there five [criteria](#) to compare them. The multicriteria table is displayed in the **Visual PROMETHEE** spreadsheet when you start the program.

Aggregation and Weighted Sum

One very common way to try to solve multicriteria decision problem is to aggregate all the criteria into a single summary score.

That can be done in several ways.

The simplest and most often used way is to compute a weighted sum (or weighted average) of the evaluations:

$$V(a) = \sum_{j=1}^k w_j \times f_j(a)$$

where:

- $w_j > 0$ is the weight allocated to criterion f_j (the more important f_j the larger w_j),
- $V(a)$ is the resulting score of action a .

The actions can then be ranked according to their V score, from the largest to the smallest value.

This approach has several limits and can be dangerous for the following reasons:

- It is a completely compensatory approach which means that a very bad evaluation on one criterion can always be compensated for by better values on other criteria. For instance it could recommend to purchase a Rolls-Royce because this car is so powerful, so comfortable, so safe, so luxurious, so well made, ... never mind the price!
- The weights of the criteria are linked to the scales of measurement of the criteria in a way that is difficult to manage. It is like adding apples and pears.
- Reducing an action to a single score means that a lot of information get lost about the conflicts among the criteria that have to be solved to make a decision. That's a very important piece of information that is understated.

The aggregation of criteria can be done in more sophisticated ways. This is the purpose of **MAUT** (multi-attribute utility theory) which is rather popular in the USA and in UK.

However **MAUT** still suffers the same limits and dangers as the simpler weighted sum approach.

Using **MAUT** approaches (such as in the Macbeth or D-Sight software) you risk to end up with unbalanced decisions.

A much better solution to get more balanced compromise solutions as a decision-maker would want it is to use another type of methods: outranking methods.

Outranking Methods

Outranking methods are based on a more familiar way of thinking. Instead of trying to define what is good and what is bad, which can be very difficult especially when you are facing a new problem for which you have very few reference points, it is usually much easier to compare one solution to another. That is the underlying principle of outranking methods:

- Outranking methods model the way the [decision-maker](#) compares two actions.
- Outranking methods do not require the decision-maker to define what is good or what is bad.
- Outranking methods do use the results of the pairwise comparison of the [actions](#) to build a relative ranking of the actions from the best one to the worst one.

That can obviously be done in many ways.

The first outranking methods were the **ELECTRE** methods developed in the 1970's by Professor Bernard Roy at the University of Paris-Dauphine in France. **ELECTRE I** focused on selecting the best action while **ELECTRE II** was one of the first ranking methods. In 1979 **ELECTRE III** introduced the notion of indifference and preference thresholds that can be found in **PROMETHEE**.

Other outranking methods have been developed such as for instance the **ORESTE** method.

The **PROMETHEE** methods were first introduced in 1982 and have been constantly improved since that time. They elaborate on the strengths of the **ELECTRE** methods and bring newer dimensions such as the **GAIA** graphical descriptive method. They are described in the next chapters.

PROMETHEE Preference Model

The **PROMETHEE** methods are among the most widely used outranking methods. This chapter describes the main elements of the preference modeling in the **PROMETHEE** methods. It is the basis to the **PROMETHEE** rankings and to the **GAIA** graphical descriptive analysis.

- [Seven Requisites](#)
- [Preference Functions](#)
- [Criteria Weights](#)
- [Pairwise Comparisons](#)

Seven Requisites

When facing a [multicriteria table](#) few information is available on the decision-maker preferences: criteria are to be maximized or minimized. With so few information the analysis of the multicriteria table is limited to checking the dominance relation and identifying efficient actions. To go further and provide the decision-maker with more interesting conclusions more information is necessary.

Dominance relation and efficiency (Pareto-optimality)

The dominance relation is based on a unanimity rule. An action a dominates an action b if it is at least as good as b on all criteria and better than b on at least one criterion.

An action is said to be efficient (or Pareto-optimal) if it is not dominated by any other action.

A possible approach to the analysis of a multicriteria table could be to identify the efficient actions as good solutions and to reject the dominated actions

The problem with dominance is that there are usually very few dominances in a [multicriteria table](#) because of the conflicting character of many criteria: when one action is better on one criterion it is often worse on other conflicting criteria. The consequence is that the number of efficient actions is usually very large. Besides dominance doesn't take into account the amplitude of the deviation between the evaluations. It makes no difference between "strong" or "weaker" dominance.

Dominance and efficiency are thus inadequate for the analysis of multicriteria tables.

In the next section seven requisites are introduced that should be included in a better multicriteria approach.

Seven requisites

For a good multicriteria method at least seven requisites are important:

- **Requisite 1:** The amplitude of the deviations between the evaluations of the actions for each criterion should be taken into account (to pay 10€ more is not the same as to pay 1000€ more). This is not the case with dominance and efficiency analysis.
- **Requisite 2:** As each criterion usually has specific scale and measurement unit, scaling effects should be avoided: it is not acceptable to obtain conclusions depending on the scales in which the evaluations are expressed (changing the currency from euros to dollars should not affect the results of the analysis). Unfortunately not all multicriteria procedures are respecting this requisite.
- **Requisite 3:** When considering the pairwise comparison of two actions a and b , the three following situations appear naturally:
 - a is preferred to b .
 - a and b are indifferent.
 - a and b are incomparable because they are very different from each other: a is much better than b on some criteria and b is much better than a on other criteria.

Of course the purpose of a MCDA method is to reduce as much as possible the number of incomparabilities, provided it is not dangerous. Systematically withdrawing incomparabilities such as in [aggregation methods](#) is more disputable.

- **Requisite 4:** Different multicriteria methods request different additional information and operate different calculation procedures so that the solutions they propose can be different. It is therefore important to develop methods being *understandable* by the decision-maker. “Black box” effect should be avoided.
- **Requisite 5:** A good multicriteria method should not include technical parameters with no significance for the decision-maker. Such parameters would indeed induce a “black box” effect.
- **Requisite 6:** A good multicriteria method should provide information on the existing conflicts between the criteria.
- **Requisite 7:** Most multicriteria methods are using weights to define the relative importance of the criteria. It is usually not easy to define values for the weights. The decision-maker can hesitate. Actually these weights can also be seen as degrees of freedom for the decision-maker to explore possible solutions. A good multicriteria method should therefore include appropriate sensitivity analysis tools.

These seven requisites have been taken into account in the development of the PROMETHEE methods:

- Requisites 1, 2 and 5 are addressed by the introduction of [preference functions](#).
- Requisite 3 is taken care of in the PROMETHEE I and II rankings.
- Requisite 4 is achieved by trying to keep the PROMETHEE methods as simple as possible.
- Requisite 6 is addressed by the GAIA method.
- Requisite 7 is addressed by the various [sensitivity analysis](#) tools that have been developed for PROMETHEE including the PROMETHEE VI procedure (decision-maker's brain).

Preference Functions

What is a preference function

Contrarily to aggregation methods (MAUT, Macbeth, D-Sight, ...), PROMETHEE makes no assumption as to what is good and what is bad. That can be dangerous when this information is not reliable: suppose you are moving to a foreign country and you are looking for a new house. You have no idea about what is cheap and what is expensive. But it is much easier for you to compare two different prices and to decide whether the price difference is important for you or not. That is the way outranking methods and PROMETHEE are working.

PROMETHEE is based on the pairwise comparison of the actions. It means that the deviation between the evaluations of two actions on a particular criterion has first to be modeled. For small deviations, there will probably be either a weak preference or no preference at all for the best action as the decision-maker will consider this deviation as small or negligible. For larger deviations, larger preference levels are expected.

With PROMETHEE preference levels are measured on a scale going from 0 to 1: 0 means no preference at all while 1 means a full preference. The deviation has to be translated to such a preference degree between 0 and 1. That is the purpose of the [preference function](#).

PROMETHEE requires to associate a [preference function](#) to each [criterion](#) in order to model the way the decision-maker perceives the measurement scale of the criterion.

There are six different types of preference function available in the PROMETHEE methods.

Six different types of preference function

From the beginning the PROMETHEE methods have included six types of preference function.

In practice they are sufficient to address most cases but some types are more used than others. Namely:

- Type I, the Usual preference function, is a good choice for qualitative criteria including a small number of evaluation levels (like the often used 5-point scale ranging from very bad to very good).
- Type IV, the Level preference function, is a good choice for qualitative criteria with a larger number of levels.
- Type V, the Linear preference function, (and Type III, V-shape, as a special case) is the best choice for most quantitative criteria.

Type I: Usual preference function



The Usual preference function is very simple. Actually it corresponds to optimization: the larger the value the better. It doesn't include any threshold.

It can be the right choice for a criterion with a few very different evaluations. That is often the case for qualitative criteria. For example, this choice would be appropriate for a 5-level qualitative scales with the following levels: very bad, bad, average, good, very good. Provided that you feel that a one-level difference is already very important. In other words, you feel that "very good" is much preferred to "good" and "average" is much preferred to "bad" and so on.

Using the Usual preference function with a quantitative criterion such as a price would mean that you consider equivalent a price difference of 1€ and a price difference of 1,000€. This would of course be not appropriate.

Type II: U-shape preference function



The U-shape preference function introduces the notion of an indifference threshold.

Type III: V-shape preference function



The V-shape preference function is a special case of the Linear preference function where the Q indifference threshold is equal to 0. It is thus well suited to quantitative criteria when even small deviations should be

accounted for.

Type IV: Level preference function



The Level preference function is better suited to qualitative criteria when the decision-maker wants to modulate the preference degree according to the deviation between evaluation levels.

Type V: Linear preference function



The Linear preference is the best choice for quantitative criteria when a Q indifference threshold is wished.

Type VI: Gaussian preference function



The Gaussian preference function is an alternative to the Linear one. It has a smoother shape but it is more difficult to set up because it relies to a single S threshold that is between the Q and P thresholds and has a less obvious interpretation. It is seldom used.

Q, P and S thresholds

Depending on the type of preference function that has been selected up to two thresholds have to be assessed. These are:

- Q - the indifference threshold
- P- the preference threshold
- S - the Gaussian threshold

Q: Indifference threshold

The Q indifference threshold is the largest deviation that is considered as negligible by the decision-maker.

To determine the value of Q one should start with a very small deviation (for instance a few euros) and increase it progressively until it is not felt to be negligible anymore. This means that Q is just below that first significant value.

P: Preference threshold

The P preference threshold is the smallest deviation that is considered as sufficient to generate a full preference.

To determine the value of P one should start with a very large deviation (for instance several thousands euros) and progressively reduce it until some hesitation arises. This means that P is slightly above this last value.

S: Gaussian threshold

The S Gaussian threshold correspond to the inflection point of the Gaussian curve (similarly to the standard deviation in statistics). It is thus a deviation for which the preference degree is equal to 0.39 so it is in between a Q and a P value. It is also more difficult to assess. A rule of thumb could be to determine a Q and a P value and to set S equal to their average ($S = (Q+P) / 2$).

Criteria Weights

The [weights](#) of the criteria are essential parameters to reflect the priorities of the [decision-maker](#).

The weights are non-negative (> 0) numbers representing the relative importance of the criteria. In **PROMETHEE** they are defined independently from the scale of measurement of the criteria. More important criteria have larger weights while less important ones have smaller weights.

We suppose here that the weights are normalized in such a way that their sum is equal to 1 (100%). This normalization is done automatically in **Visual PROMETHEE**.

Assessing weights to the criteria is not straightforward. It involves the priorities and perceptions of the decision-maker. The weights also represent his/her space of freedom. **Visual PROMETHEE** includes several [sensitivity analysis](#) tools to help the decision-maker in that task.

Pairwise Comparisons

PROMETHEE is an outranking method. It is based on the principle of pairwise comparison of the actions.

A first step in the **PROMETHEE** modeling is thus to compare each action with each other.

This is done by computing a multicriteria preference index in the following way:

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

where:

- $w_j > 0$ is the normalized weight allocated to criterion f_j (the more important f_j the larger w_j),
- $P_j(a, b)$ is the value of the preference function for criterion f_j when action a is compared to action b .

With normalized weights, $\pi(a, b)$ is a number between 0 and 1. It expresses how much a is preferred to b taking into account all the criteria and their weights. For instance:

- if $\pi(a, b) = 0$:
All the $P_j(a, b)$ values are equal to 0 which means that a is never even slightly preferred to b on any criterion.
- if $\pi(a, b) = 1$:
All the $P_j(a, b)$ values are equal to 1 which means that a is strongly preferred to b on all the criteria.

So that:

- $\pi(a, b) \approx 0$ means that there is a weak preference for a over b .
- $\pi(a, b) \approx 1$ means that there is a strong preference for a over b .

The following properties hold:

$$\begin{cases} \pi(a, a) = 0 \\ 0 \leq \pi(a, b) \leq 1 \\ 0 \leq \pi(a, b) + \pi(b, a) \leq 1 \end{cases}$$

Missing values

Missing values can arise in the [multicriteria table](#) for various reasons, e.g.:

- Because the information is simply not available for some actions. That can be due to the lack of access to the data, to budget or time constraints for instance.
- Because a criterion can be pertinent for only some of the actions.

This problem can be addressed in different ways.

Replacing missing values by arbitrary values

As most **MCDA** methods rely on the availability of all the evaluations in the multicriteria table, the generally used approach is to replace the missing values by some replacement values. The replacement value can be:

- A fixed value, such as for instance 0. This is obviously completely arbitrary and can introduce unwanted biases in the analysis. For instance replacing a missing cost value by 0€ is really dangerous.
- A value computed from the distribution of the available evaluations on the corresponding criterion (for instance the arithmetic average). This will reduce the biases but it is still arbitrary to assume that the missing value is central.
- An estimate of the missing value, provided that it is possible to do so.

Excluding actions or criteria with missing values

A second possibility is to remove from the analysis any action or criterion for which there are missing data.

This raises two problems:

- In the case of a single missing value, should the action or the criterion be removed?
- When the number of missing value is small, such a procedure can lead to the removal of interesting actions or important criteria for which interesting information is actually available.

That approach can however make sense when there are many missing values that are concentrated on one or a few number of actions or criteria. Indeed, if one only has a very limited knowledge about some action or some criterion, it could be wise to exclude this action or this criterion from the analysis.

Handling missing values at the pairwise comparison level

One advantage of **PROMETHEE** being a pairwise comparisons method is that it is possible to handle missing at that level.

When two actions a and b are compared, the multicriteria preference index is computed:

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

It involves the values taken by the preference functions associated to the criteria and not directly the evaluations of the actions themselves. If for criterion f_j either $f_j(a)$ or $f_j(b)$ is missing, a value has to be defined for $P_j(a, b)$. The more neutral value in such case is 0 : this way no assumption is made about any preference between a and b . This is quite different from the replacement approach where a is preferred to some actions and some actions are preferred to a depending on the replacement value. In this case, no preference is generated. Actually, if all the evaluations of an action are missing, this action will have a net flow score equal to 0.

This procedure is implemented in **Visual PROMETHEE**.

PROMETHEE Rankings

There are two **PROMETHEE** rankings. They are based on the computation of preference flows.

- [Preference Flows](#)
- [PROMETHEE I Partial Ranking](#)
- [PROMETHEE II Complete Ranking](#)

Preference Flows

The preference flows are computed to consolidate the results of the pairwise comparisons of the actions and to rank all the actions from the best to the worst one.

Three different preference flows are computed:

- Φ^+ (ϕ^+): the positive (or leaving) flow
- Φ^- (ϕ^-): the negative (or entering) flow
- Φ (ϕ): the net flow

Φ^+ (ϕ^+): positive (leaving) flow

$$\phi^+(a) = \frac{1}{n-1} \sum_{b \neq a} \pi(a, b)$$

The positive preference flow $\phi^+(a)$ measures how much an action a is preferred to the other $n-1$ ones. It is a global measurement of the strengths of action a . The larger $\phi^+(a)$ the better the action.

Φ^- (ϕ^-): negative (entering) flow

$$\phi^-(a) = \frac{1}{n-1} \sum_{b \neq a} \pi(b, a)$$

The negative preference flow $\phi^-(a)$ measures how much the other $n-1$ actions are preferred to action a . It is a global measurement of the weaknesses of action a . The smaller $\phi^-(a)$ the better the action.

Φ (ϕ): net flow

The net preference flow $\phi(a)$ is the balance between the positive and negative preference flows:

$$\phi(a) = \phi^+(a) - \phi^-(a)$$

It thus takes into account and aggregates both the strengths and the weaknesses of the action into a single score.

$\phi(a)$ can be positive or negative. The larger $\phi(a)$ the better the action.

PROMETHEE I Partial Ranking

The **PROMETHEE I ranking** is a partial ranking. This means that all the [actions](#) are not necessarily compared and that the ranking can include [incomparabilities](#).

The ranking is based on the two following [preference flows](#):

- Phi+ (ϕ^+): the positive (or leaving) flow,
- Phi- (ϕ^-): the negative (or entering) flow.

As the two preference flows are consolidating the [pairwise comparisons](#) of the actions according to opposite points of view, they usually induce two different rankings on the set of actions. The **PROMETHEE I** partial ranking is the intersection of these two rankings. So action a is preferred to action b in the **PROMETHEE I ranking** if and only if it is preferred to b according to both preference flows. That is:

$$aP^I b \text{ if and only if } \phi^+(a) \geq \phi^+(b) \text{ and } \phi^-(a) \leq \phi^-(b)$$

where P^I stands for "is preferred to in the I ranking" and at least one of the two inequalities should be strict (otherwise the two actions are indifferent (in a tie)).

Whenever the two preference flows give opposite rankings of the actions the actions become [incomparable](#).

The **PROMETHEE I partial ranking** can be represented in several ways. While older software like PromCalc and Decision Lab used a network representation, Visual PROMETHEE introduces more visually appealing and informative representations:

- The [PROMETHEE Rankings](#) window makes it easy to compare the rankings corresponding to the two preference flows.
- The [PROMETHEE Diamond](#) display is a two-dimensional alternative representation that is useful to detect the proximities of the actions.
- The [PROMETHEE Table](#) window gives access to the flow scores for an easy export to Excel for instance.

PROMETHEE II Complete Ranking

The **PROMETHEE II ranking** is a complete ranking. This means that all the [actions](#) are compared and that the ranking includes no [incomparabilities](#) even when comparison is difficult. The resulting ranking can thus be more disputable, especially in the presence of strongly conflicting criteria.

The ranking is based on the [net preference flow](#). It combines the two other preference flows in a single summary score. So action a is preferred to action b in the **PROMETHEE II ranking** if and only if it is preferred to b according to the net preference flow. That is:

$$aP^{II} b \text{ if and only if } \phi(a) > \phi(b)$$

where P^{II} stands for "is preferred to in the PROMETHEE II ranking".

The **PROMETHEE II complete ranking** can be represented in several ways. While older software like PromCalc and Decision Lab used a network representation, Visual PROMETHEE introduces more visually appealing and informative representations:

- The [PROMETHEE Rankings](#) window makes it easy to compare the rankings corresponding to the two preference flows.
- The [PROMETHEE Table](#) window gives access to the flow scores for an easy export to Excel for instance.
- The [PROMETHEE Rainbow](#) window provides a disaggregated view of the ranking.
- The [Walking Weights](#) window presents the ranking under a bar chart form.

Rank reversal

Rank reversal refers to the fact that the relative positions of two [actions](#) in a ranking can change when another action is added to or deleted from the set of actions.

This phenomenon is inherent to pairwise-comparisons-based multicriteria decision aid methods such as for instance **PROMETHEE**, **ELECTRE**, **AHP** or **Macbeth**. Indeed in such methods the scores ([preference flows](#) in **PROMETHEE**) used to rank the actions are built from the [pairwise comparisons](#) of all the actions. Different sets of actions thus provide different scores and rank reversal can occur.

In the case of the **PROMETHEE** methods rank reversal is limited. It can be proved for instance that:

- The **PROMETHEE** rankings are consistent with the dominance relation. In other words if an action is dominated by another one it will never be preferred to that other one in the **PROMETHEE** rankings.
- Rank reversal can only happen when the flow values of the actions are relatively close to each other. Which means that rank reversal mostly occurs between actions that are very close to each other in the **PROMETHEE** rankings. It is also important to keep in mind that a poor choice of [preference function](#) (for instance using the Usual preference function with continuous numerical criteria) can increase the occurrence of rank reversals. The visual representations used in **Visual PROMETHEE** make it easy to detect such cases.

GAIA

GAIA is the descriptive companion method to **PROMETHEE**.

- [Unicriterion Net Flows](#)
- [GAIA Plane](#)
- [GAIA 3D](#)
- [PROMETHEE VI Brain](#)

Unicriterion Net Flows

The net [preference flow](#) can be computed for each criterion separately. The unicriterion net flow for criterion f_j is then defined as:

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

And we have the following property:

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

The unicriterion net flow values are always numbers between -1 (worst possible value) and +1 (best possible value).

This decomposition (or disaggregation) is interesting for at least two reasons:

- It is possible to evaluate the relative performance of an [action](#) on any [criterion](#), taking into account the [preference function](#) defined by the [decision-maker](#). That information is used to draw the [action profiles](#) and the [GAIA Webs](#).
- Using the unicriterion net flows the [multicriteria table](#) can be represented in a k -dimensional space taking into account the scales of the criteria with the [preference functions](#) defined by the [decision-maker](#). That is the basis of **GAIA**.

GAIA Plane

The objective of **GAIA** is to describe the major features of the decision problems graphically:

- How much are actions different or similar to each other? Are there clusters of similar actions?

- Which criteria are conflicting with each other? Are there strong conflicts to solve? Are there groups of criteria expressing similar preferences?
- What is the impact of the weighing of the criteria on the **PROMETHEE** rankings?

The **GAIA** analysis starts from the [unicriterion net flow](#) table:

	ϕ_1	ϕ_2	...	ϕ_j	...	ϕ_k
a_1	$\phi_1(a_1)$	$\phi_2(a_1)$	...	$\phi_j(a_1)$	...	$\phi_k(a_1)$
a_2	$\phi_1(a_2)$	$\phi_2(a_2)$	...	$\phi_j(a_2)$	...	$\phi_k(a_2)$
\vdots	\vdots	\vdots		\vdots		\vdots
a_i	$\phi_1(a_i)$	$\phi_2(a_i)$	...	$\phi_j(a_i)$	...	$\phi_k(a_i)$
\vdots	\vdots	\vdots		\vdots		\vdots
a_n	$\phi_1(a_n)$	$\phi_2(a_n)$	...	$\phi_j(a_n)$	...	$\phi_k(a_n)$

This table is similar to but contains more information than the original [multicriteria table](#) because the [preference functions](#) defined by the [decision-maker](#) are taken into account. It also means that each [criterion](#) is expressed on the same normalized net flow scale (scores between -1 and +1). Each [action](#) is thus associated to a k -dimensional profile and can be seen as a point in the k -dimensional space.

Similar actions are expected to be close to each other and their location in the k -dimensional space indicates what are their strengths and what are their weaknesses. The relative positions of the actions also reveals the links and the possible conflicts between the criteria. It is however difficult to use this information when there are more than two or possibly three criteria because the k -dimensional space cannot be visualized.

GAIA uses a dimension-reduction technique that is borrowed from statistical data analysis. This technique is called the **principal components analysis (PCA)**.

PCA allows to define a series of orthogonal dimensions (principal components) that keep as much information as possible on the relative positions of the actions in the k -dimensional space.

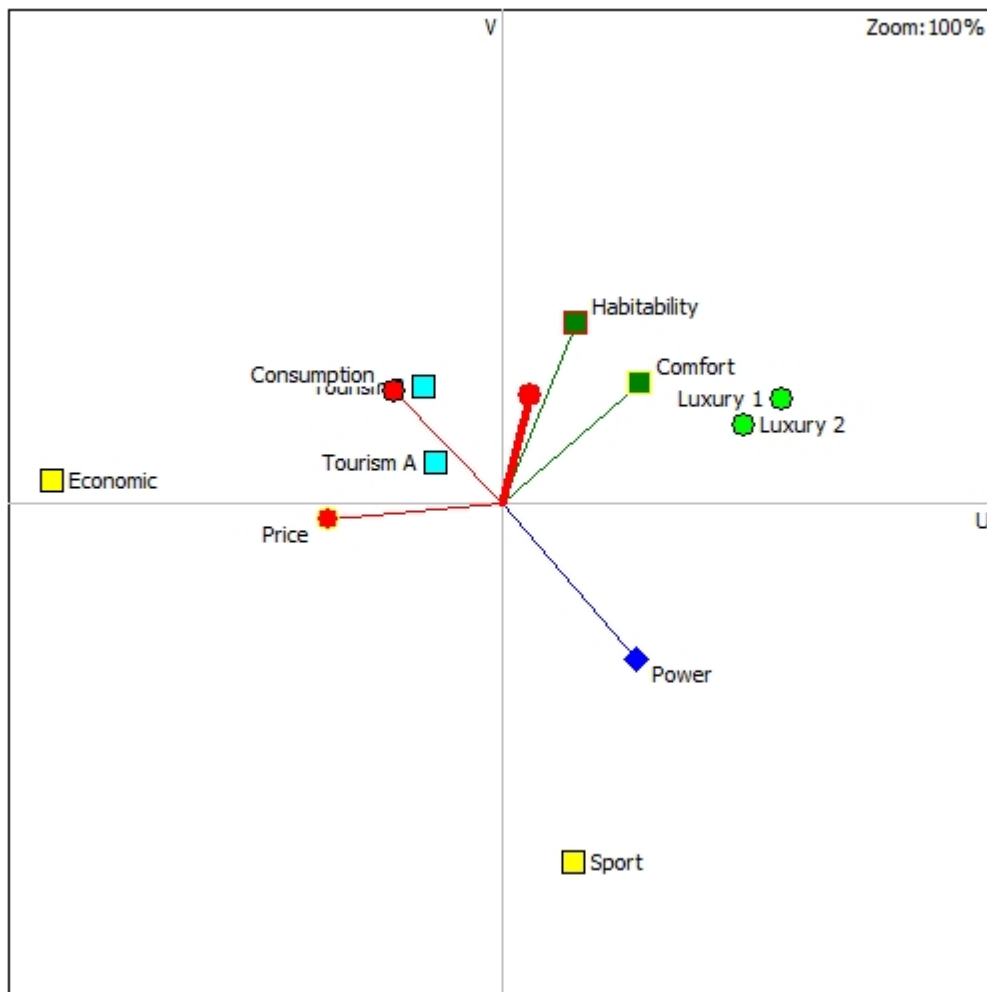
In the original **GAIA** method the two first principal components (named U and V) are computed and displayed in the **GAIA plane**.

The **GAIA plane** is the best two-dimensional representation of the multicriteria problem. It retains the maximum possible quantity of information from the k -dimensional representation. This quantity of information can be measured and is usually called Δ . In **Visual PROMETHEE** it appears under the name "Quality" in the [GAIA window](#).

Three different pieces of information appear in the **GAIA plane**:

- [Actions](#) are represented by points.
- [Criteria](#) are represented by axes.
- The [weights](#) of the criteria are represented by the decision axis.

The following figure shows the **GAIA plane** for the **Visual PROMETHEE** demo. In this case the quantity of information contained in the plane is equal to 89,9% (as shown in the [GAIA window](#) in **Visual PROMETHEE**)



Actions

Actions are represented by points. We have the following properties:

- Actions that are similar to each other appear close to each other in the **GAIA** plane. In the above picture, it is the case of the two **Luxury** cars.
- Actions that are very different from each other appear far away from each other in the **GAIA** plane. It is the case for the **Economic** and the **Sport** cars.

Subsets of similar actions can thus be identified.

In the example, four subsets of actions are identified:

- Luxury cars (**Luxury 1** and **Luxury 2**),
- Tourism cars (**Tourism A** and **Tourism B**),
- **Economic**,
- **Sport**.

Criteria

Criteria are represented by axes drawn from the center of the plane. We have the following properties:

- Criteria expressing similar preferences are represented by axes oriented in similar directions. That is the

case for example of **Habitability** and **Comfort**.

- Criteria expressing conflicting (opposite) preferences are represented by axes oriented in opposite directions. That is the case for example of **Power** and **Consumption**.
- The length of a criterion axis is representative of its relative discriminating power: the longer the axis the more discriminating the criterion.

Subsets of criteria expressing similar preferences can thus be identified and the relative discriminating power of the criteria can be assessed.

In the example, three subsets can be identified:

- Luxury criteria (**Habitability** and **Comfort**) in the North-East direction,
- Economy criteria (**Price** and **Consumption**) in the West direction,
- **Power** on its own in the South-East direction.

The identification of subsets of criteria make it easier to understand the conflicts that have to be solved in making a decision. In this example, it appears that the decision-maker has to compromise between three conflicting objectives: luxury, economy and power.

Actions and criteria

The position of the actions with respect to the criteria axes indicate how well actions are performing on the different criteria.

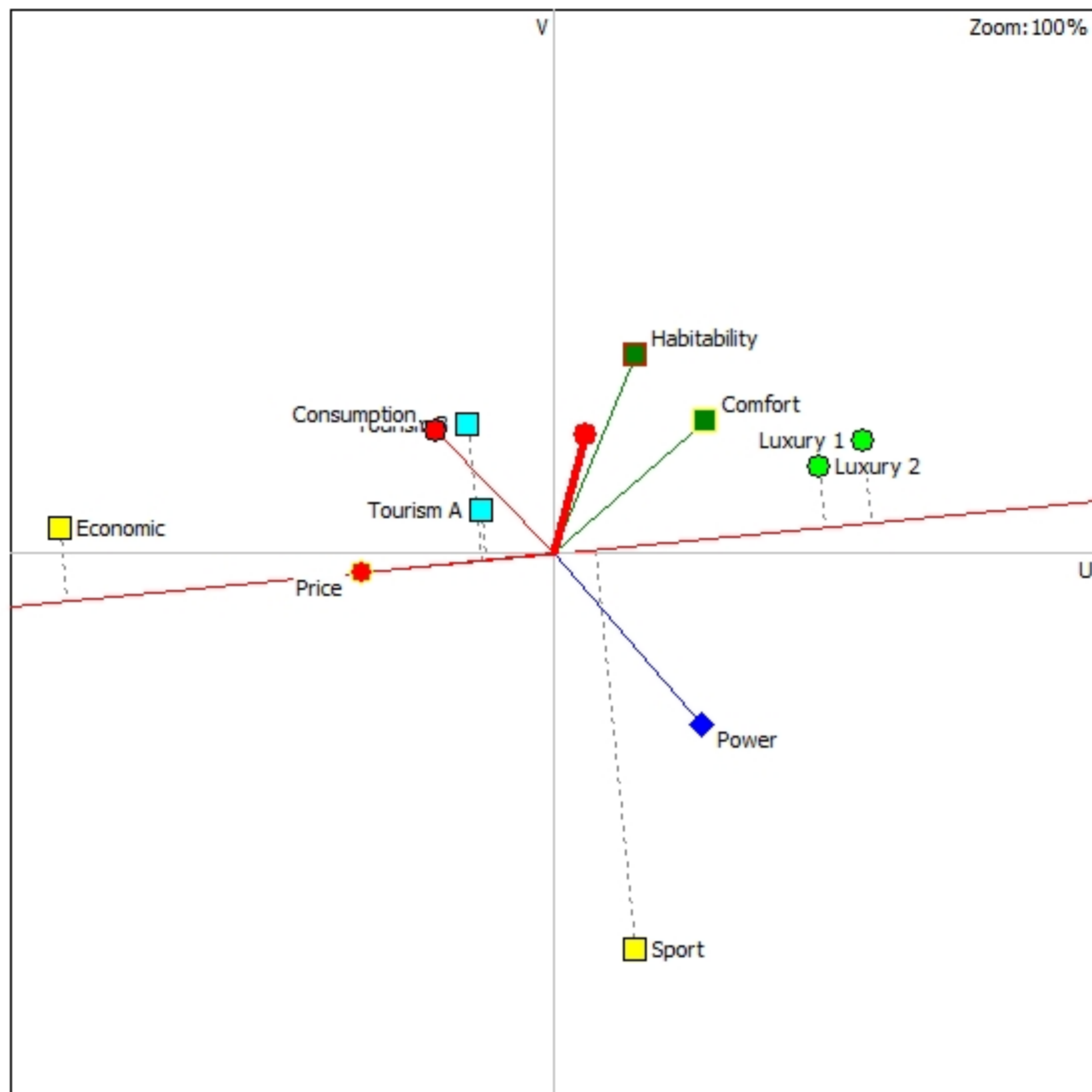
Let us consider the criterion **Price** in the example. What is important is the direction of the corresponding axis: in this case the **Price** axis is oriented to the left. This means that the more an action is located to the left of the **GAIA** plane the better it is with respect to criterion **Price**.

Visual PROMETHEE allows you to check this by selecting a criterion in the "Show axis..." local menu. Choosing **Price** as the criterion to display gives the following graphic. The red line extends the direction of the criterion axis. It is oriented. In this case the 'best' values are on the left and the 'worst' are on the right side according to the criterion axis orientation.

Each action is projected orthogonally on the criterion direction. The projections show the relative performance of the actions on the selected criterion. The distance to the criterion is meaningful. What matters is the place where the action projects on the criterion. In the example we see that:

- **Economic** is clearly the best (the cheapest car),
- **Tourism A** and **B** are the second best (cheapest) cars and have very similar prices,
- **Sport** is more expensive,
- **Luxury 1** and **2** are the most expensive cars/

This information is of course limited by the quality of the **GAIA** plane.



Decision Axis

The **Decision Axis** is a visual representation of the weighing of the criteria in the **GAIA** plane. As weights are allocated to the criteria the best actions in the **PROMETHEE** rankings are more or less influenced by the different criteria.

The **Decision Axis** is similar to a weighted average of the criteria axes. It indicates the direction of the **PROMETHEE II** ranking and thus show which criteria are in agreement with the **PROMETHEE II** ranking and which are not. This can be helpful to detect under- or over-weighted criteria. In the above example one can see that with the current weights of the criteria **PROMETHEE** will probably propose actions that are good on **Habitability**, **Comfort** and **Consumption** but probably worse on **Price** and **Power**. If the decision-maker feels that this is not appropriate according to his/her priorities, he/she should increase the weights of **Price** or **Power**.

When the weights of the criteria are modified, the position of the **Decision Axis** changes. This can be checked interactively in **Visual PROMETHEE** using the [Walking Weights](#) window.

The length of the **Decision Axis** is important to take into account when analyzing the **GAIA** plane. Indeed if the **Decision Axis** is short that means that it is at a large angle from the **GAIA** plane and that it is not well represented. The orientation of the **Decision Axis** is then much less informative. Actually the **Decision Axis** is the projection of the weight vector (**Decision Stick**) on the **GAIA** plane. A 3D view of the **Decision Stick** can be displayed in the **GAIA** window to emphasize the angle between the stick and the **GAIA** plane.

Action Profiles

The positions of the actions in the **GAIA** plane are directly related to the profiles of the actions. However the **GAIA** plane has a limited quality level and there can be some distortions. It is thus interesting to look at the exact action profiles to complement the **GAIA** information. The [Action Profile](#) window is available for this purpose in **Visual PROMETHEE**. In this display [unicriterion net flow](#) scores are displayed in a bar chart.

GAIA Webs

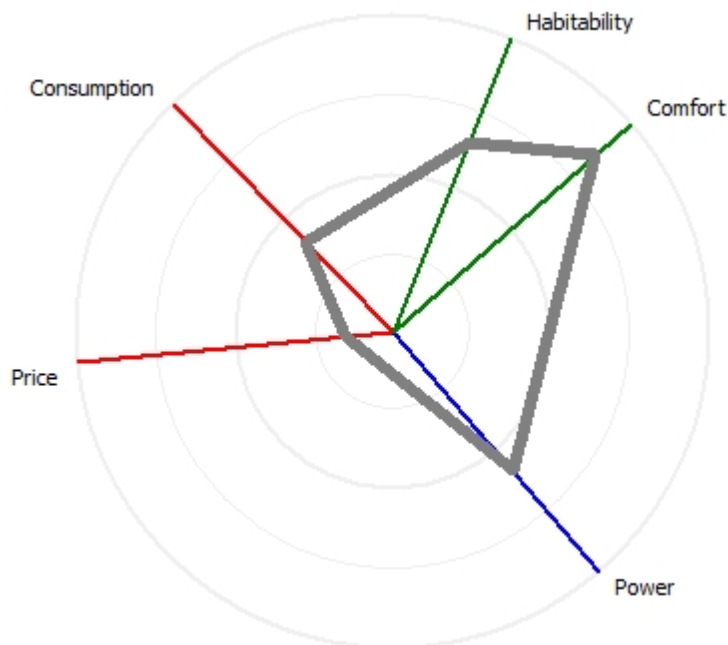
GAIA Webs are an alternative display to **Action Profiles**.

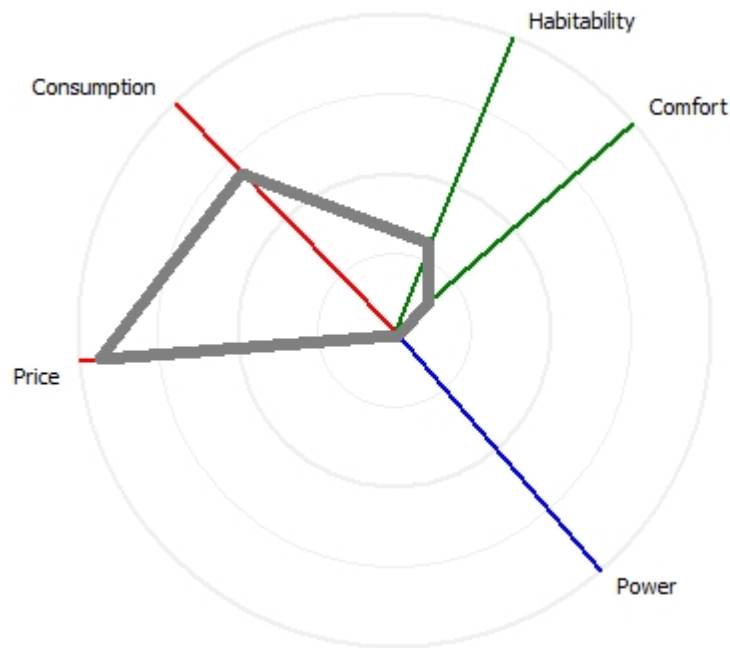
Spiderweb graphs such as for instance in the D-Sight software are nice-looking but can be misleading. The problem is that they are strongly dependent on the arbitrary ordering of the criteria in the multicriteria table. When the ordering of the criteria is changed quite different shapes can be observed and it is thus very difficult to understand what is displayed. Spiderwebs are very poor graphical representations.

The **GAIA Web** is a smarter alternative web display. Instead of displaying the different criteria at arbitrary angles, the positions of the criteria axes in the **GAIA** plane are used as a reference. In that way criteria that are strongly correlated are close to each other in the **GAIA Web** and the web shape is easier to understand.

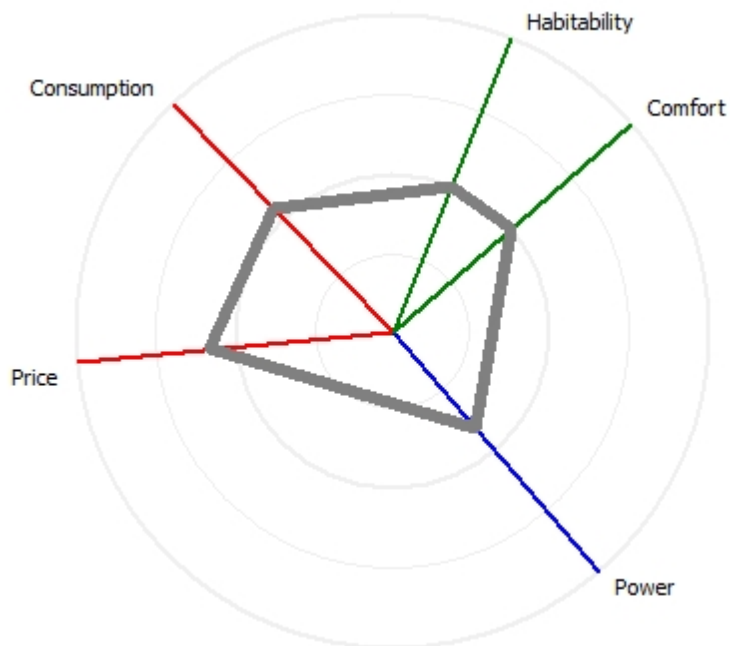
[Unicriterion net flow](#) scores are represented on the web: -1 values are drawn at the center of the web while +1 values are drawn on the outer circle. A polygon is then drawn connecting the different criteria.

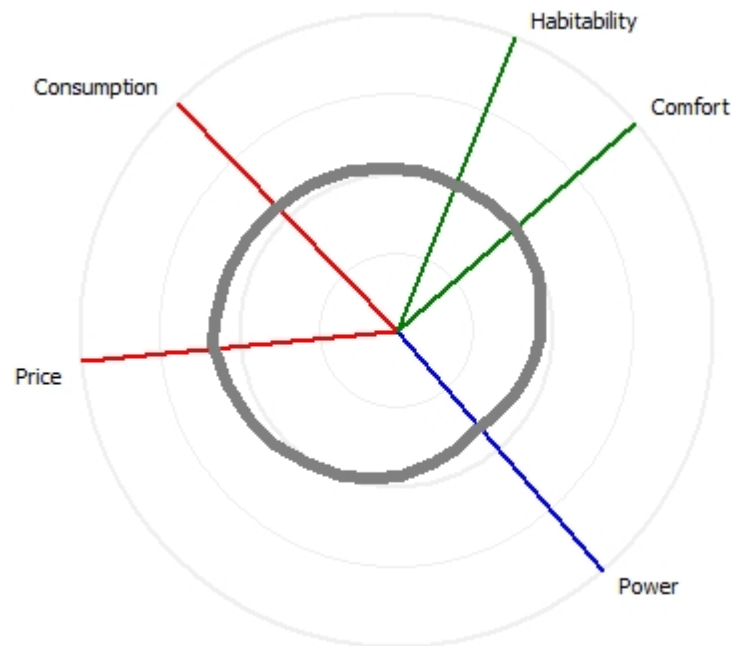
Below are two examples of typical **GAIA Webs**. On the left side is the **GAIA Web** for action **Luxury 1**. On the right side is the **GAIA Web** for action **Economic**. The two shapes are very different from each other. For **Luxury 1** the criteria **Habitability** and **Comfort** are very good while **Price** is a concern. For **Economic** the criteria **Price** and **Consumption** are very good. These are clearly two opposite profiles.





GAIA Webs can be drawn in two ways. Either showing a polygon with straight lines between criteria or as a "rounded" shape. In the latter case, a curve is drawn instead of a straight line from one criterion to the next one. The curve is drawn in a such way that its distance from the center of the web goes progressively from one unicriterion net flow value to the next. This provides smoother and better balanced webs. As an example let us look at the **Tourism A** car. It is a very average action with unicriterion net flow scores close to 0 on all criteria. Below are its "straight" and "rounded" **GAIA Webs**. The 'rounded' web better shows the uniformly average character of the action. In the 'straight' version this is less obvious as the straight lines can come closer to the center between criteria (as for instance between **Price** and **Power**) and give a false impression of weakness.





GAIA 3D

The classical **GAIA** analysis is limited to the two first principal components (U and V in **Visual PROMETHEE**) yielding a two-dimensional representation of the decision problem: the **GAIA** plane.

When the quality (Δ) of the **GAIA** plane is low (let us say as a rule of thumb less than 70%) the analysis can be misleading as it excludes a potentially part of information contained in the multicriteria problem.

There are several possible workarounds:

- Partial analyses can be undertaken. Indeed the quality of the **GAIA** plane usually increases when the number of [criteria](#) or the number of [actions](#) is reduced. For instance:
 - **GAIA** planes can be computed for subsets of criteria (such as for instance individual [clusters](#) in **Visual PROMETHEE**) thus giving several higher quality views instead of one single lower quality view.
 - For a global view of the decision problem, subsets of criteria (criteria [groups](#) or clusters in **Visual PROMETHEE**) can be aggregated before performing the **GAIA** computation (using the "Grouped" property in **Visual PROMETHEE**). In this case each subset will appear as a single dimension in the **GAIA** plane. Of course the relations between the criteria within a same subset cannot be analyzed in this way.
 - **GAIA** planes can also be computed for separate subsets of actions (action [categories](#) in **Visual PROMETHEE**).

In any cases these solutions provide with partial views of the decision problem.

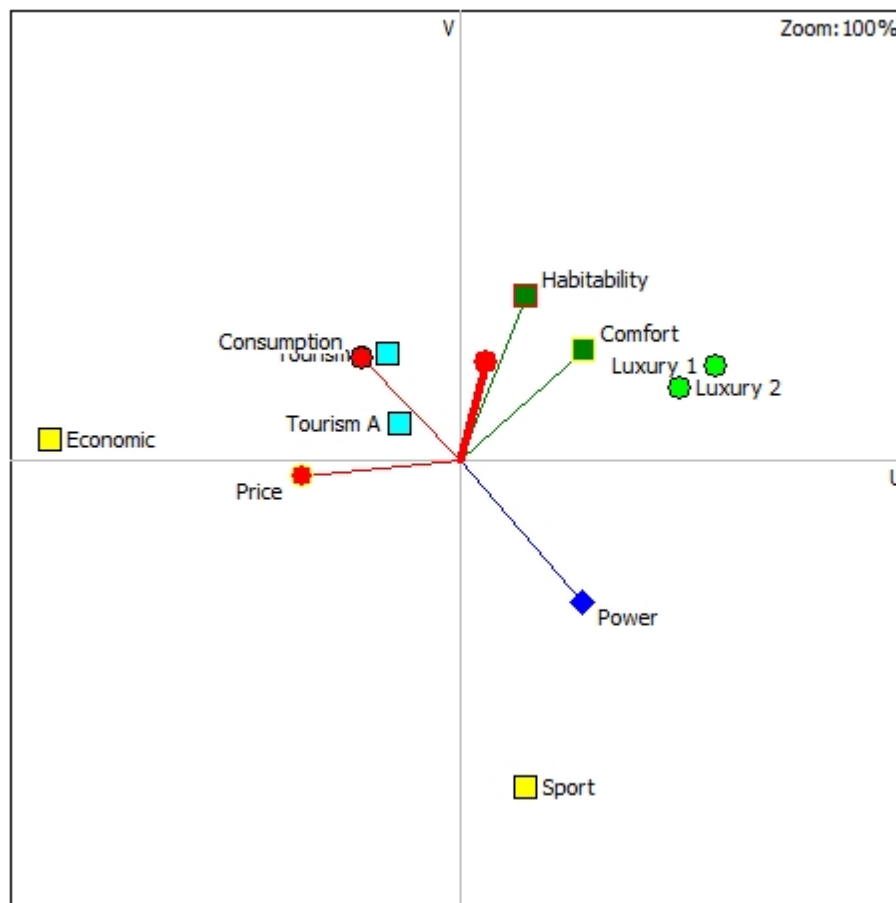
- Additional principal components can be computed. This results in a higher dimension representation of the decision problem. In practice more than three principal components are difficult to visualize as we are used to live in a three-dimensional world. Another solution to improve the quality of the **GAIA** analysis while maintaining a global view of the decision problem is thus to compute a third principal component (W in **Visual PROMETHEE**). This has however some limits:
 - Visualizing three-dimensional data on a computer screen can be tricky as perspective is difficult to render. A workaround is to look at separate two-dimensional views (U-V, U-W or V-W). This

- is possible in **Visual PROMETHEE**.
- The quality improvement can be limited: often when the two-dimensional representation quality is insufficient the third dimension only brings a marginal improvement as the decision problem typically involves many conflicting criteria that are impossible to represent accurately in a low dimension space.

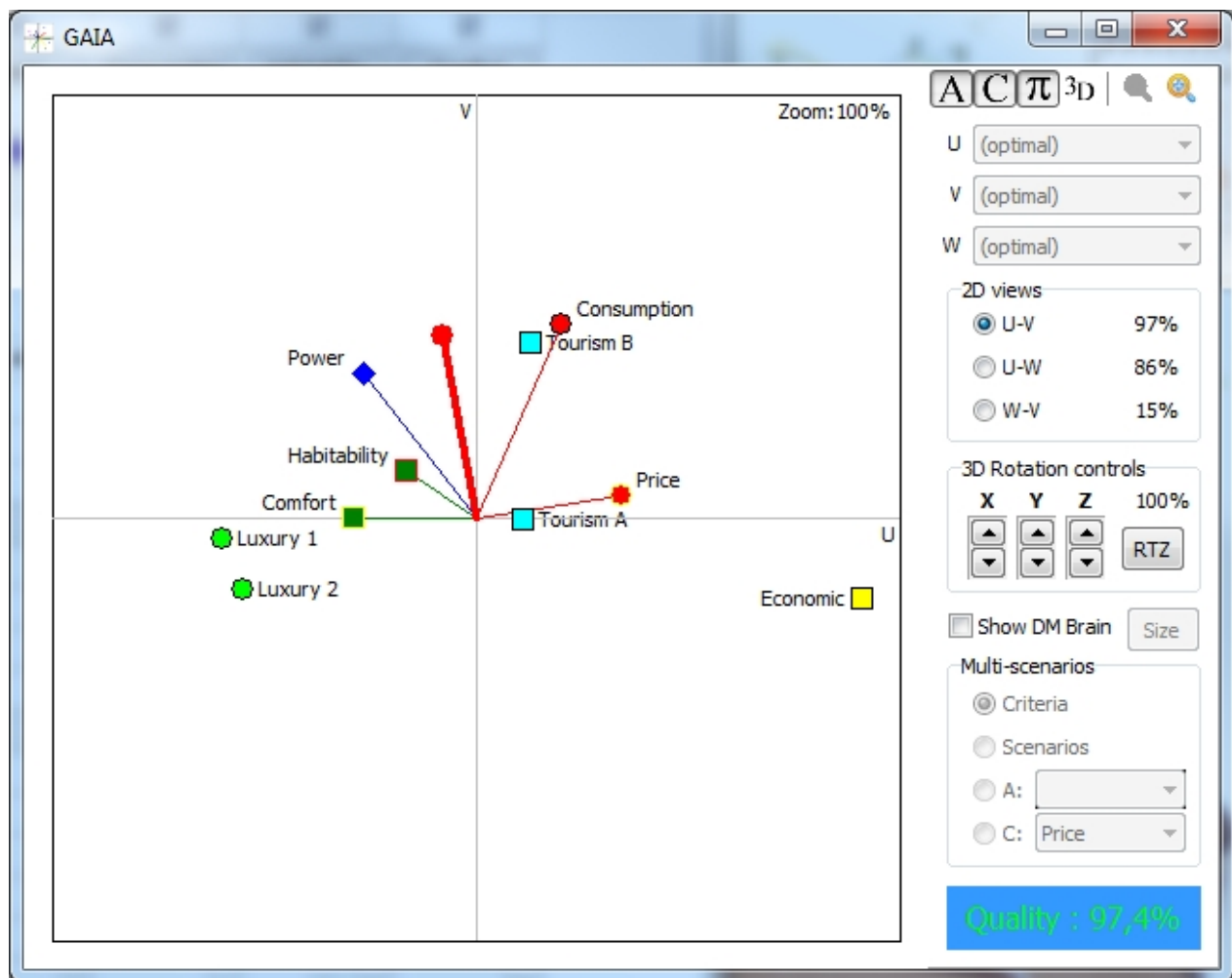
Most **GAIA** plane features can be extended to the 3D representation.

In the **Visual PROMETHEE** demo problem the U-V plane has a very high quality level close to 90% (actually 89.9%). The third axis thus brings only a more limited quality improvement. As can be seen on the **GAIA** window, the 3D representation quality level is equal to 98%. When analyzing the U-W (quality level: 70%) or W-V (quality level: 37%) planes it should be remembered that the third axis is responsible for 8% within the total quality level.

A simple calculation shows the respective quantities of information (rounded to integer values) for U (70% - 8% = 62%), V (37% - 8% = 29%) and W (8%). The U axis is thus by far the most informative axis. A look at the U-V plane can explain this: except for the **Sport** car all the other actions are spread over the U axis with smaller vertical differences. Thus most important differences between these five other cars can be explained by a single axis.



This is confirmed if the **Sport** car is deactivated (in the next screenshot): the U-V plane quality level is now equal to 97% and the 3D quality level is 100%. The corresponding axes quantities of information are the following: 83% (86% - 3%) for U, 12% (15% - 3%) for V and only 3% for W.



PROMETHEE VI Brain

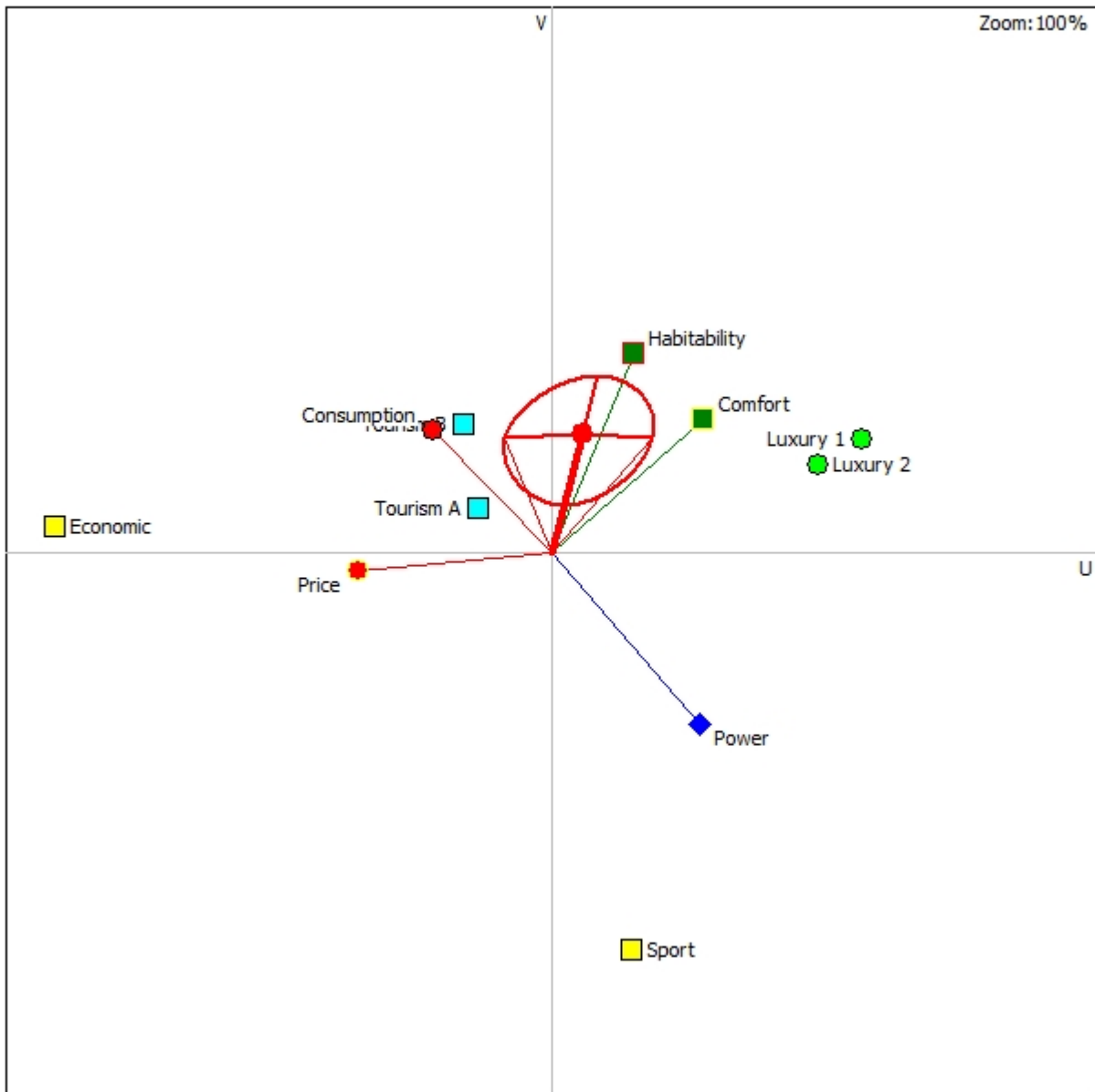
Allocating [weights](#) to the [criteria](#) can be a difficult step in the decision process and the [decision-maker](#) can hesitate to give a precise weight to each criterion. Typically some order of magnitude is known (such criterion is felt much more important than an other, two criteria are felt equally important, etc) but precise values are difficult to define.

Even when the decision-maker feels comfortable with a set of weights it is interesting to examine what happens to the [PROMETHEE rankings](#) when the weights are slightly changed. Are they stable or very sensitive? This is a weight [sensitivity analysis](#).

PROMETHEE and **GAIA** provide the decision-maker with several possibilities with respect to weight [sensitivity analysis](#).

PROMETHEE VI goes beyond the simple weight sensitivity analysis as it enables the decision-maker to explore his/her space of freedom by defining upper and lower limits for the weights of the criteria. Within these limits many different weightings and **PROMETHEE** rankings are possible. For each such weighing the Decision Axis has a corresponding position in the **GAIA** plane. The area determined by the tip of the **Decision Axis** in the **GAIA** plane when all the possible weightings are considered is drawn on the **GAIA** plane. It is usually called the **Decision-Maker Brain (Brain)**

The red ellipse in the following screenshot is the outline of the **Brain** when the weights of the criteria are allowed to vary from 16% to 24% (i.e. 20% +/- 4%). It is interesting to notice that the **Brain** is located entirely in the upper part of the **GAIA** plane. Thus the **Decision Axis** is always close to the **Consumption**, **Habitability** and **Comfort** criteria and the **Sport** car will never be at the top of the **PROMETHEE** ranking with weights within these limits.



Actually there are two possible situations:

1. When the **Brain** is entirely located on one side of the **GAIA** plane the **Decision Axis** is always oriented in the same direction and the **PROMETHEE** rankings are expected to be stable. The preferred actions are easy to identify.
2. When the **Brain** overlaps the center of the **GAIA** plane it means that the **Decision Axis** can be oriented in any direction. The **PROMETHEE** rankings can thus be very different depending on the values of the weights within the limits set by the decision-maker. The problem is thus much harder to solve.

Sensitivity Analysis

Sensitivity analysis is essential to multicriteria decision aid. Indeed many parameters have to be set up in a multicriteria model. With the **PROMETHEE** and **GAIA** methods these include:

- The choice of the [preference functions](#) and of the related thresholds.
- The choice of the [weights](#) allocated to the [criteria](#).

The results of the **PROMETHEE** and **GAIA** analysis are of course dependent from these parameters. It is thus important to check that slight variations of the parameters don't have to large influence on the analysis

results.

An interesting property of the **PROMETHEE** methods is that the **preference flows** are linear functions of the weights of the criteria. This makes it easy to perform sensitivity analyses.

In **Visual PROMETHEE** several tools are available for weight sensitivity analysis:

- The [Walking Weights](#) analysis.
- The [Visual Stability Intervals](#).
- The [Decision Maker Brain](#) in the [GAIA](#) window.
- The [Balance of Power](#) window for multiple scenarios.

GDSS PROMETHEE

Most multicriteria decision aid methods have been designed in the context of a single [decision-maker](#).

With **PROMETHEE** and **GAIA** this means that a single person expresses his/her preferences by defining the [criteria](#) and their associated [preference functions](#) and allocating [weights](#) to the criteria.

In many decision problems however several persons are usually involved. They can be actual decision-makers such as:

- family members who have to agree on their new car, or their new home;
- directors in a company board who have to agree on an investment strategy;
- country leaders at UN;

or they can be stakeholders involved in the decision process. For instance in the demo **TutorSites** plant location problem available with **Visual PROMETHEE** four stakeholders are involved:

- **Industrial**: this is the actual decision-maker, the company that wants to build a new plant.
- **Political**: this is the political (regional) authority that has to agree on the project and to deliver a permit for building the plant. They are not an actual decision-maker but they have a strong impact on the decision process.
- **Environmental**: here are the environmental protection groups that are concerned about the project. They have their own objectives and have some power on the decision process.
- **Social**: worker's unions can also influence the decision process. They have their own objectives.

Every stakeholder can have different objectives, different priorities or even different evaluations on subjective criteria that are measured on qualitative scales. What is then the best consensus solution?

The **GDSS** extension of **PROMETHEE** allows to take into account such situations.

This is achieved by defining several [scenarios](#) for the decision problem.

All the scenarios share the same lists of actions and criteria. Everything else can be different from one scenario to another:

- Different evaluations.
- Different [preference functions](#) (min/max, preference function type, thresholds).
- Different criteria [weights](#).

Each scenario can be analyzed separately using **PROMETHEE** and **GAIA**. Individual (single scenario) rankings and **GAIA** planes are thus easily obtained.

However, it is possible to make more interesting multi-scenario analyses. This is the purpose of **GDSS PROMETHEE**.

In a first step multi-scenario preference flows are computed to aggregate the preferences from the different scenarios. Consensus (multi-scenario) **PROMETHEE I** and **II** rankings can then be computed. Finally, the properties of the preference flows allow for several multi-scenario extensions of the **GAIA** analysis.

GDSS PROMETHEE is explained in the next pages:

- [Multi-scenario preference flows](#)
- [Consensus PROMETHEE rankings](#)
- [Multi-scenario GAIA analysis](#)
 - **GAIA-Criteria**
 - **GAIA-Scenarios**
 - **GAIA-Action**
 - **GAIA-Unicriterion**

Multi-scenario Preference Flows

Let us generalize the [multicriteria table](#) to the case where S scenarios are defined.

For each scenario s ($s=1, \dots, S$) we have the following multicriteria table:

	f_1	f_2	...	f_j	...	f_k
a_1	$f_1^s(a_1)$	$f_2^s(a_1)$	...	$f_j^s(a_1)$	...	$f_k^s(a_1)$
a_2	$f_1^s(a_2)$	$f_2^s(a_2)$	...	$f_j^s(a_2)$	...	$f_k^s(a_2)$
\vdots	\vdots	\vdots		\vdots		\vdots
a_i	$f_1^s(a_i)$	$f_2^s(a_i)$	...	$f_j^s(a_i)$	...	$f_k^s(a_i)$
\vdots	\vdots	\vdots		\vdots		\vdots
a_n	$f_1^s(a_n)$	$f_2^s(a_n)$	...	$f_j^s(a_n)$	...	$f_k^s(a_n)$

where $f_j^s(a_i)$ is the evaluation of action a_i on criterion f_j for scenario s .

Based on these S single scenario multicriteria tables, the three **PROMETHEE** [preference flows](#) can be computed separately for each scenario s :

$$\phi^{+s}(a) = \frac{1}{n-1} \sum_{b \neq a} \pi_s(a, b)$$

$$\phi^{-s}(a) = \frac{1}{n-1} \sum_{b \neq a} \pi_s(b, a)$$

$$\phi^s(a) = \phi^{+s}(a) - \phi^{-s}(a)$$

where π_s is the multicriteria preference index computed for scenario s .

Multi-scenario preference flows are then computed as the weighted sum of the single scenario flows:

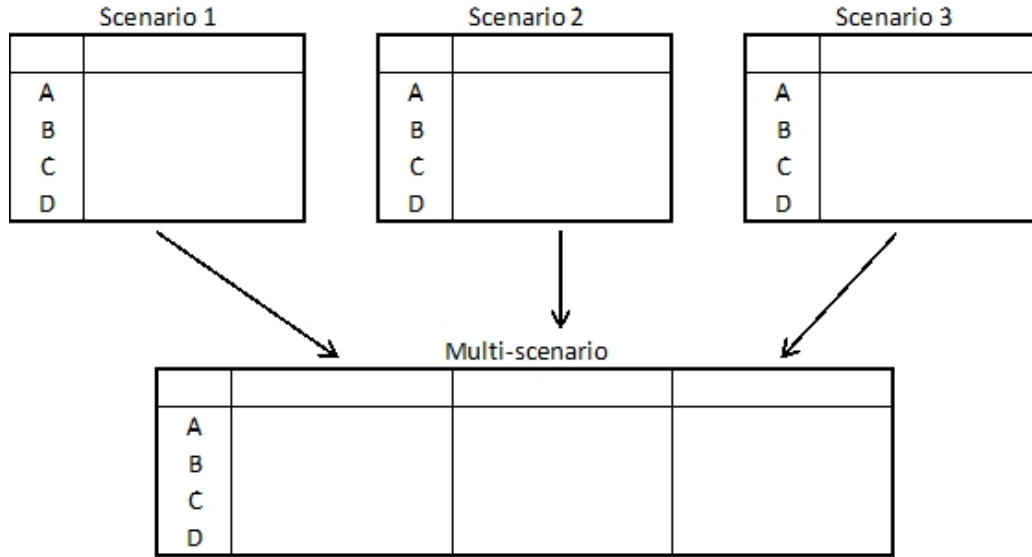
$$\phi_c^+(a) = \sum_{s=1}^S W_s \cdot \phi^{+s}(a)$$

$$\phi_c^-(a) = \sum_{s=1}^S W_s \cdot \phi^{-s}(a)$$

$$\phi_G(a) = \sum_{s=1}^S W_s \cdot \phi^s(a)$$

where W_s is the normalized weight allocated to scenario s .

This computation is the same as if all the single scenario multicriteria tables were all set side to side in a larger multicriteria table and the weights of the criteria were adjusted taking into account the weights of the scenarios. The multi-scenario preference flows can thus be used to produce **PROMETHEE** rankings taking into account all the scenarios and their relative importance.



The [unicriterion net flows](#) can also be computed separately for each scenario:

$$\phi_i^s(a) = \frac{1}{n-1} \sum_{b \neq a} [P_i^s(a, b) - P_i^s(b, a)]$$

where P_j^s is the preference function for criterion f_j in scenario s .

According to the previous definitions the following properties hold:

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

where:

$$\phi_j^G(a) = \sum_{s=1}^S W_s \cdot \phi_j^s(a)$$

These are used in the **GDSS GAIA** extensions.

Consensus PROMETHEE Rankings

The **PROMETHEE I** and **II** rankings can be computed for each scenario base on the single scenario preference flows.

Consensus (multi-scenario) rankings can also be computed from the multi-scenario preference flows. They are rankings that encompass the preference information from all the scenarios. They are thus proposing good consensus solutions.

Multi-scenario GAIA

Four different **GAIA** extensions are available in a multi-scenario context:

- [GAIA-Criteria](#)
- [GAIA-Scenarios](#)
- [GAIA-Action](#)
- [GAIA-Unicriterion](#)

The **TutorSites** demo problem is used to illustrate this section.

GAIA-Criteria

In the **GAIA-Criteria** analysis the multi-scenario unicriterion net flows are displayed. There is one axis for each [criterion](#) or grouped [group](#) or [cluster](#).

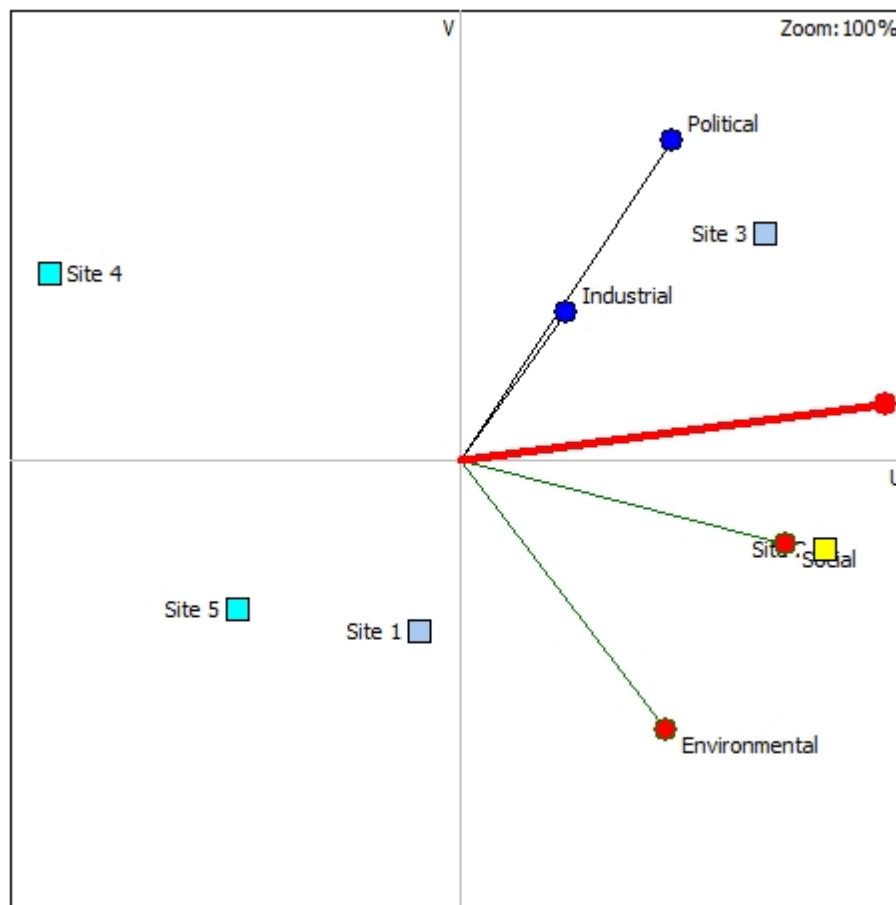


This view is interesting when the criteria are rather objective and similar evaluations are observed in the different scenarios. In such cases the **GAIA-Criteria** display will be very similar to the single scenario **GAIA** views. On the other hand when some criteria are evaluated quite differently from one scenario to another these differences will not appear in **GAIA-Criteria** as the multi-scenario unicriterion flows are weighted averages of the single scenario flows. The **GAIA-Unicriterion** analysis can be used to analyze these differences and the **GAIA-Scenarios** analysis can be useful to better understand the differences between the scenarios.

In the above screenshot it is obvious that two sites (**Site 3** and **Site 2**) are globally preferred but there is no way to detect different evaluations in criteria such as for instance **Employment** or **Environment**.

GAIA-Scenarios

In the **GAIA-Scenarios** analysis the single scenario multicriteria net flows are displayed. There is one axis for each [scenario](#) or grouped [coalition](#).



In this view, the multicriteria preferences for all the scenarios are compared. It is possible to identify groups of scenarios with similar points of view and to detect conflicts among scenarios.

In our example there are two groups of scenarios:

- **Industrial** and **Political** for which **Site 3** seems to be the best choice.
- **Social** and **Environmental** for which **Site 2** seems to be the best choice.

These two groups of scenarios are oriented in different but not completely opposite directions. This means that the conflict between the two groups is not so important. Indeed, all scenarios agree that **Site 3** and **Site 2** are much better solutions than the other three sites. The **GDSS** situation could have been much more conflicting.

Beyond the **GAIA-Scenarios** analysis it is interesting to be able to identify the origin of the conflicts between the scenarios. There are several possibilities:

- Conflicts can arise from quite different preferences ([preference functions](#)) or priorities ([weights](#)). In such cases it is usually difficult to make changes and it can be quite hard to reach a consensus solution.
- Conflicts can also arise from different perceptions of a single [criterion](#) or [action](#). Indeed the definition of a criterion can be unclear for some decision-maker and lead to different evaluations. In the same way, information related to a specific action can be different for some decision-makers. To identify such situations and try to establish a more common and more objective evaluation basis for all the decision-makers (scenarios) the **GAIA-Unicriterion** and **GAIA-Action** analyses can be used.

GAIA-Action

In the **GAIA-Action** analysis a single selectable [action](#) is displayed as it is evaluated in the different [scenarios](#) or grouped [coalitions](#). There is one axis for each [criterion](#) or grouped [group](#) or [cluster](#).

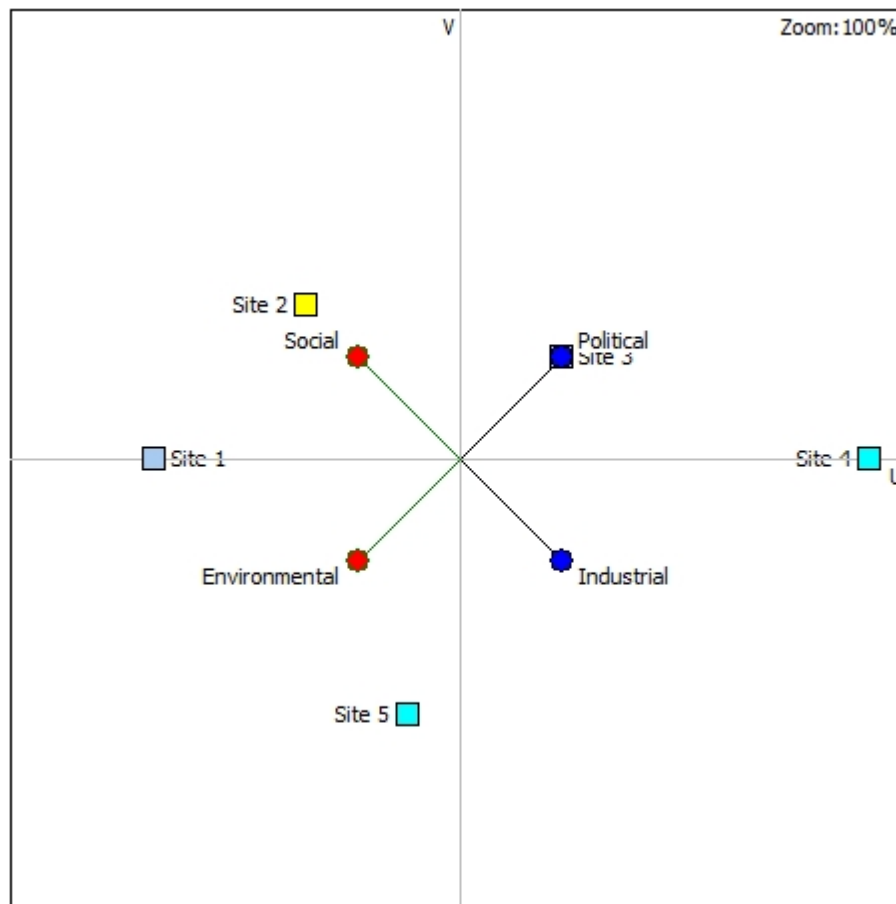
This feature is not implemented yet.

GAIA-Unicriterion

In the **GAIA-Unicriterion** analysis a single selectable criterion is displayed as it is evaluated in the different scenarios or grouped coalitions. There is one axis for each [scenario](#) or grouped [coalition](#).

The two following screenshots from the demo problem show two typical and quite different situations.





The first screenshot is for the criterion **Investment**. This criterion is computed in an objective way and thus the evaluations are the same in all the scenarios. Accordingly all the sites are aligned on the U axis. In this case the V and W axes are meaningless. There is a perfect agreement on the evaluation of the sites on this criterion.

The second screenshot is for the criterion **Employment**. In this case the scenario axes are strongly conflicting. Indeed **Industrial** and **Environmental** want to minimize this criterion while **Political** and **Social** want to maximize it. Moreover the evaluations themselves are different from one scenario to another. This indicates that the definition of this criterion is not the same for all the decision-makers. A more precise definition of the criterion or splitting the criterion into two or more sub-criteria could be helpful to establish a better common basis for evaluation and to reduce the sources of conflict between the decision-makers.

PROMETHEE V Selection

Many multicriteria problems are about selecting one [action](#) among a set of possible actions. It is the case in the two **Visual PROMETHEE** examples:

- In **TutorCars** somebody wants to buy **one** new car.
- In **TutorSites** a company wants to build **one** new plant.

In other cases [decision-makers](#) can be interested in selecting a **subset** of actions according to their multicriteria evaluation and to additional **constraints**. That type of decision problem is also known as **portfolio management**. Here are some examples:

- **R&D projects**: Given a set of project proposals which ones should be selected? The best ones of course according to criteria such as expected return or risk level. But there is usually a total budget constraint. There can be incompatibilities between some projects that cannot be selected at the same time. Or a wish to balance the number of selected projects among departments or types of activities.

- **Financial investment:** What is the best portfolio of investment? Taking into account individual asset evaluation (such as return or risk) as well as for instance diversification constraints.
- **Networking:** A company in the distribution sector want to establish a network of shops in a new area. What is the best selection given budget limits, competitors, customers location, etc?
- **Marketing:** To launch a new product several marketing actions are available (Internet, TV, newspapers, billboards, ...). What is the best mix?

Without additional constraints it would seem logical to select the actions that are ranked at the top of the **PROMETHEE** ranking. But the first ranked action could for instance be a very expensive option and could exhaust most of the available budget. A better solution could then be not to select the first action but rather several others that are individually less appealing but that globally provide a better performance.

PROMETHEE V is designed to solve such problems. It works in two steps:

1. A **PROMETHEE II** analysis of the data is made. The multicriteria net flow ϕ ([Phi](#)) provides with a global evaluation of the actions taking into account all the criteria.
2. A **0-1 linear program** is then defined as follows in order to solve the multiple selection problem:
 - A binary (0-1) variable x_i is associated to each action a_i : $x_i = 1$ means that action a_i is selected while $x_i = 0$ means it is not.
 - The objective is to select actions in such a way that the sum of the ϕ (Phi) values of the selected actions is as large as possible:

$$\max \sum_{i=1}^n \phi(a_i) \cdot x_i$$

Without additional constraints all actions with a positive net flow (Phi) value will be selected as this makes for the largest positive sum of flows.

- Additional linear constraints can be added according to the requirements of the decision-maker. For instance:
 - Number of actions to select: if exactly m actions have to be selected, the following constraint will be added to the linear program:

$$\sum_{i=1}^n x_i = m$$

- Maximum total budget: if the maximum budget available is B and each action a_i has a corresponding cost equal to b_i then this constraint can be added:

$$\sum_{i=1}^n b_i \cdot x_i \leq B$$

- Incompatibility between two actions: if actions a_i and a_l cannot be selected at the same time, the following constraint can be used:

$$x_i + x_l \leq 1$$

- Many other types of constraints can be added to the linear program such as for instance geographical or sectoral diversification.

The 0-1 linear program is solved in **Visual PROMETHEE** using a branch and bound algorithm. The

[PROMETHEE V window](#) displays the optimal solution and allows for what-if analyses.

PROMETHEE Sort

Sorting vs ranking

Many [MCDA](#) methods are designed to solve **ranking** problems, i.e. to rank [actions](#) from the best to the worst one according to several [criteria](#) and to the preferences ([preference functions](#)) and priorities ([weights](#)) of the [decision-maker](#). It is the case of [PROMETHEE I and II](#). It is perfectly appropriate whenever one has to make a decision among a set of possible actions and to identify the best possible action.

There are however other decision-making situations. Sometimes the decision-maker has some reference points about what to expect from the actions and is able to define different [classes](#) of actions such as for instance:

- "good" and "bad" actions,
- "good", "average" and "bad" customers,
- different consumer behaviors,
- different types of companies, ...

The problem is then to associate each action to one class. It is a **sorting** problem.

Ranking is relative while sorting is absolute. In the **PROMETHEE II** ranking there is always a best (first ranked) and a worst (last ranked) action but that doesn't mean that the best action is a "good" one or that the last one is a "bad" one. Indeed all actions could be "good" or could be "bad". In a sorting problem all the actions could be "bad" or all the actions could be "good".

The next step in a **sorting** problem is to characterize the different classes. What is a "good" action? What is a "bad" action? Clearly some additional information is required.

In **PROMETHEE Sort** as in most **MCDA sorting** methods this is done by defining reference actions or [profiles](#). The profiles can be either actual actions or fictive ones.

Different sort problems

Sorting problems can be subdivided into different categories according to at least two factors:

- **Classes:** can be ordered according to the preferences of the decision-maker (e.g. "good", "average" or "bad" customers) or unordered (e.g. different consumer behaviors).
- **Profiles:** can be used to identify the boundaries between ordered classes or be typical (central) actions.

PROMETHEE Sort provides the decision-maker with appropriate analyses in each possible case.

PROMETHEE Sort - Ordered classes

Let us consider a multicriteria table as defined [previously](#).

We suppose that the preferences are modeled as in the **PROMETHEE I** and **II** methods.

We suppose that C ordered classes have been defined by the decision-maker: Cl_1, Cl_2, \dots, Cl_C where Cl_1 is the least preferred class and Cl_C is the most preferred one. To each class one or several profiles are attached. Let us note b_p^c ($p = 1, 2, \dots, P_c$) the P_c profiles attached to the class Cl_c . These profiles can be either boundary or central profiles.

Boundary profiles

In the case of boundary profiles, we suppose that the boundary profiles associated with one class correspond to the upper boundary of that class. The boundary profiles for the most preferred class (Cl_C) are

thus ignored.

With boundary profiles, some additional consistency is required: indeed as the classes are ordered so are their boundaries. A requirement is thus that the profiles for class Cl_i should dominate the profiles for class Cl_j when $i > j$ (Cl_i is preferred to Cl_j).

In order to assign an action a to a class Cl_c , **PROMETHEE Sort** compares the action to all the profiles. The **PROMETHEE** ranking method is used for this purpose: action a is compared to all the profiles and the preference flows are computed.

Central profiles

In the case of central profiles, the profiles associated with one class correspond to typical actions belonging to that class.

PROMETHEE Sort then computes a distance from the action to sort to the different classes. The action is assigned to the closest class.

PROMETHEE Sort - Unordered classes

When the classes are unordered, boundary profiles do not make any sense. The **PROMETHEE Sort** analysis is thus limited to central profiles and is similar to that for ordered profiles.

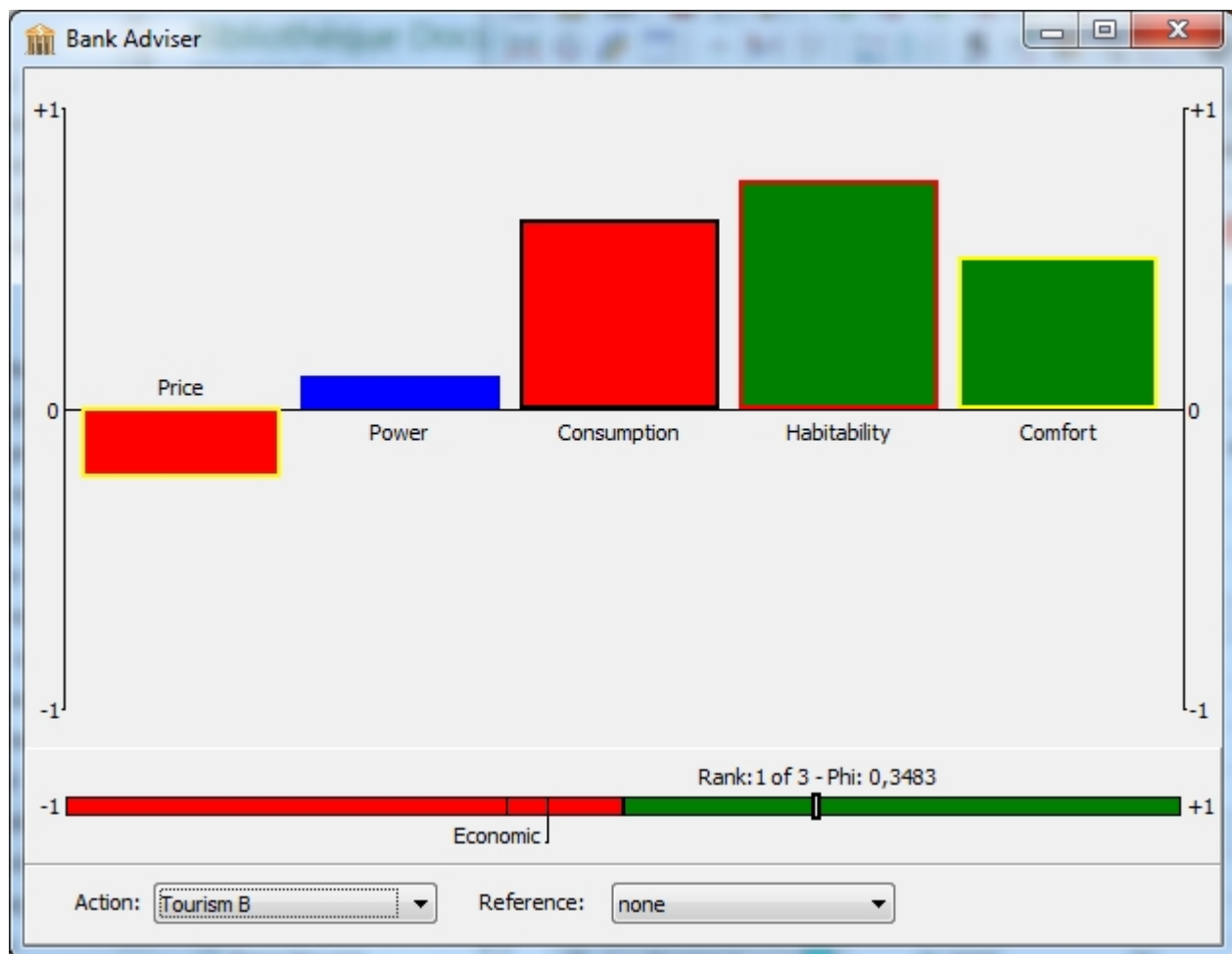
Bank Adviser

Bank Adviser allows to evaluate [actions](#) with respect to a [reference set](#) of actions. The reference set can be for instance:

- a set of well-known actions,
- a subset of actions (for instance geographically defined),
- a set of reference points (fictive actions),
- a peer-group.

While the **PROMETHEE** [Rankings](#) are based on the pairwise comparison of all the actions and thus provide the [decision-maker](#) with a relative evaluation of the actions, Bank Adviser compares each action to a reference set.

This means that the action is compared to the reference actions only. The resulting Phi score is thus a measurement of how well the action compares to the reference set. It is independent from the other actions evaluations.



Performance Analysis

The **PROMETHEE** Performance Analysis extension has been developed for cases where two sets of criteria have to be compared and a notion of performance is important. This is similar to the Input/Output model used in Data Envelopment Analysis (DEA).

This work is still ongoing research.

When measuring the efficiency of operational units (or DMU's - decision-making units - in the language of DEA), it is common to compare input criteria (different resources allocated to the units) to output criteria (results generated by the activity of the units) and to look for some kind of "best" output/input ratio. The **PROMETHEE** Performance Analysis extension provides decision-makers with two tools that can be used in such a context:

- Performance Aggregated Score: a global output/input ratio score.
- I-O Efficiency: a graphical view of input vs output criteria emphasizing a notion of efficiency.

To use these two tools in **Visual PROMETHEE** two [clusters](#) of [criteria](#) have to be defined: one cluster should contain all the input criteria and the other should contain all the output criteria.

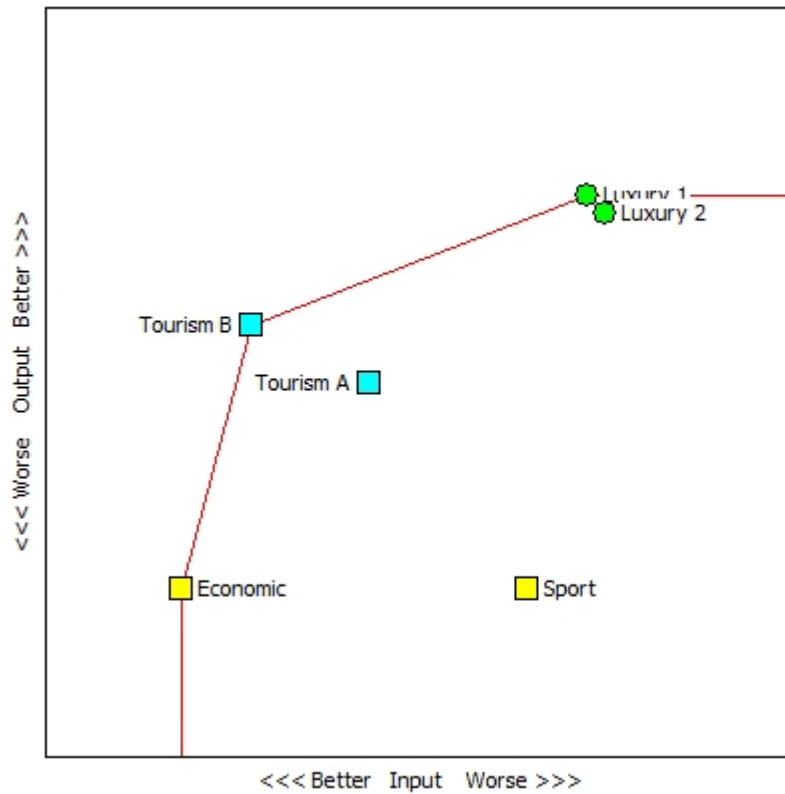
Performance Aggregated Score

The Performance Aggregated Score is computed as a ratio of normalized output and input net flow scores as follows:

I-O Efficiency

The I-O Efficiency frontier is drawn in the plane corresponding to the input and output net flow scores.

Actions located on the efficiency frontier (red line) have input and output net flow scores that are not dominated by any other action.



Additional examples and exercises

Here are four additional examples that are described and analyzed and for which some practical exercises are proposed.

The corresponding data files are automatically installed with **Visual PROMETHEE**.

- [Powerplants](#): A powerplant location problem.
- [Hypermarkets](#): A distribution network management problem including a [PROMETHEE V](#) application.
- [Cars](#): Another approach to the car selection problem with an emphasis on the [Decision-maker](#) Brain in [GAIA](#).
- [CUV](#): An actual 2012 car selection problem involving CUV's (Compact Utility Vehicles). Guess what car [Bertrand Mareschal](#) is driving today!

Powerplants

The context

Given the ever increasing demand for electricity in Europe, the European political authority has decided to build a new large hydro-electrical power plant. Six national projects (sites) have been proposed by six European countries, and six evaluation criteria have been defined by the European authority in order to select the best project:

The actions

Six national sites:

- a_1 : **Italy**
- a_2 : **Belgium**
- a_3 : **Germany**
- a_4 : **Sweden**
- a_5 : **Austria**
- a_6 : **France**

The criteria

- f_1 : **Manpower**
- f_2 : **Power**
- f_3 : **Construction** cost
- f_4 : **Operation** cost
- f_5 : Number of **villages** to evacuate
- f_6 : **Safety** level

The model

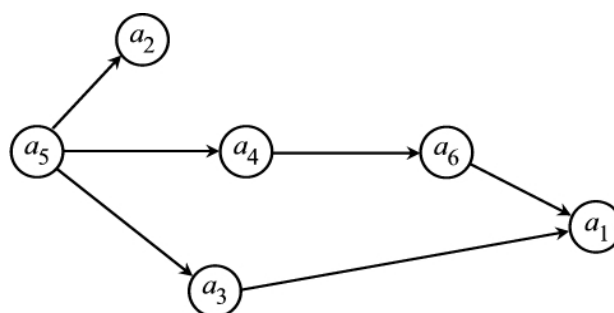
Some criteria are to maximize, others are to minimize. [Preference functions](#) and [weights](#) have been associated to the [criteria](#). In a first step, without well established priorities, all the weights have been set to equal values ($w_j = 1, j = 1, 2, \dots, 6$).

All the data are given in the following table.

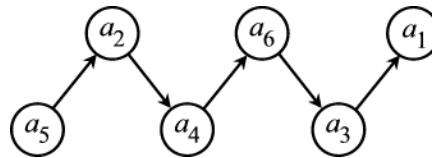
Visual PROMETHEE Business - Powerplants.vpg (saved)						
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<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Scenario1	Manpower	Power	Construction	Operation	Villages	Safety
Unit	personnel	MW	M€	M€	villages	
Cluster/Group						
Preferences						
Min/Max	min	max	min	min	min	max
Weight	1.00	1.00	1.00	1.00	1.00	1.00
Preference Fn.	U-shape	V-shape	Linear	Level	Usual	Gaussian
Thresholds	absolute	absolute	absolute	absolute	absolute	absolute
- Q: Indifference	10	n/a	50	1.0	n/a	n/a
- P: Preference	n/a	300	500	6.0	n/a	n/a
- S: Gaussian	n/a	n/a	n/a	n/a	n/a	5
Statistics						
Minimum	40	580	200	2.0	1	1
Maximum	94	960	1000	9.7	8	10
Average	69	760	583	5.9	5	6
Standard Dev.	19	142	248	2.6	2	3
Evaluations						
<input checked="" type="checkbox"/> Italy	80	900	600	5.4	8	5
<input checked="" type="checkbox"/> Belgium	65	580	200	9.7	1	1
<input checked="" type="checkbox"/> Germany	83	600	400	7.2	4	7
<input checked="" type="checkbox"/> Sweden	40	800	1000	7.5	7	10
<input checked="" type="checkbox"/> Austria	52	720	600	2.0	3	8
<input checked="" type="checkbox"/> France	94	960	700	3.6	5	6
All Scenario1						
Actions: 6 (6 active) Criteria: 6 (6 active) Scenarios: 1 (1 active) Locale: Belgium [€/.] Saved						

The analysis

The two next figures show the [PROMETHEE rankings](#) as networks (arrows indicate preferences):



PROMETHEE I Partial Ranking



PROMETHEE II Complete Ranking

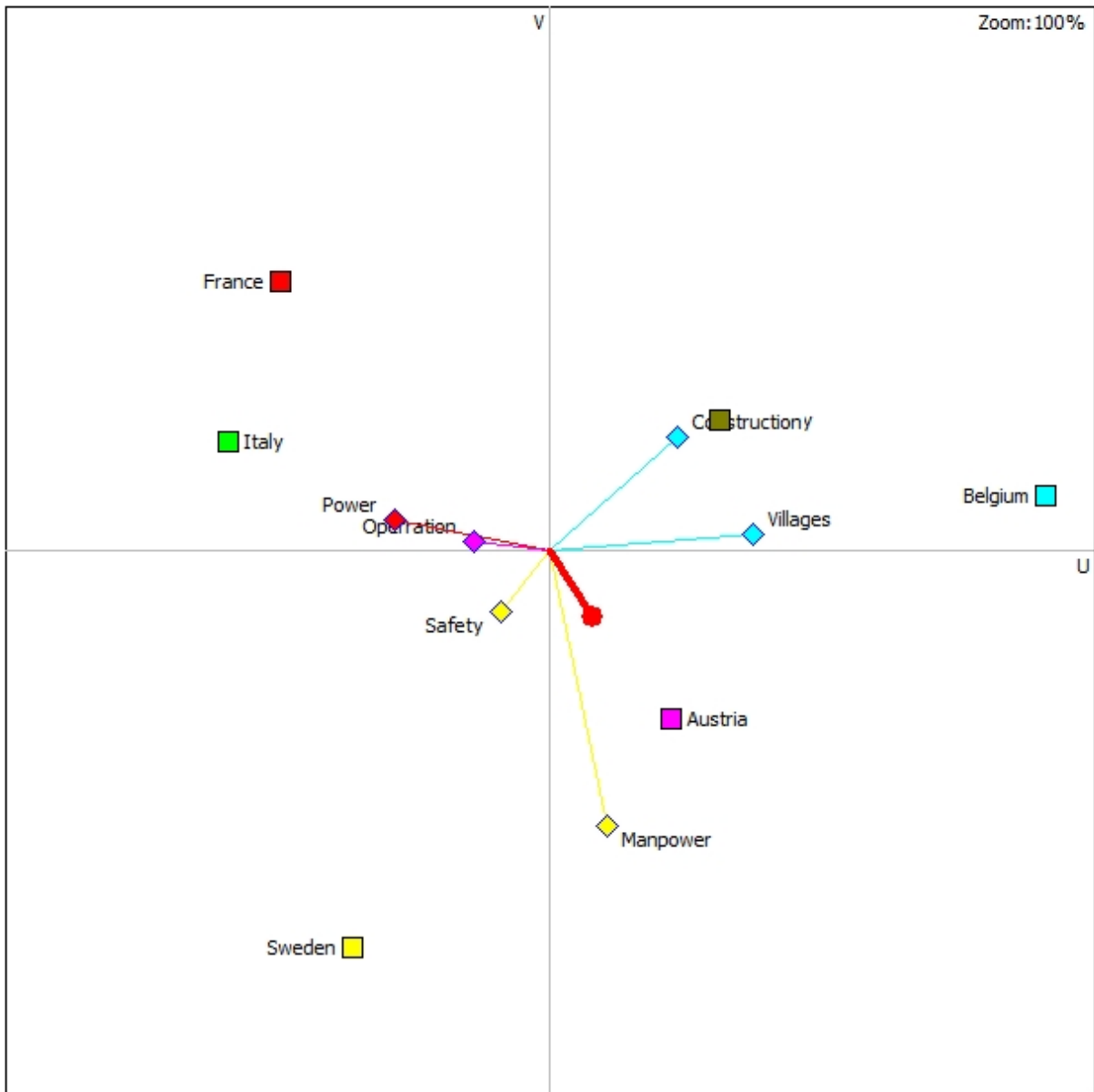
Use **Visual PROMETHEE** to confirm these two rankings. Check the [incomparability](#) between a_1 (**Italy**) and a_2 (**Belgium**) by comparing their [profiles](#): these are very opposite to each other.

When the weights of the criteria are modified, the resulting rankings can be quite different. For instance if a weight of 50 (50%) is allocated to criterion **Power** and weights of 10 (10%) are allocated to each other criterion, **France** becomes the best location. If a larger weight is allocated to the **Villages** criterion (55%, with 9% for each other criterion), **Belgium** becomes the best choice. Check this using **Visual PROMETHEE**.

The [GAIA](#) plane shows three conflicting groups of criteria. Can you identify them? What about the reliability (quality level) of the two-dimensional representation?

Belgium seems to be a very good solution for the criteria **Villages** and **Construction**, but it is very bad on **Power** and **Operation**. It is the opposite for **Italy** and **France**. Check this in **Visual PROMETHEE** by looking at the [action profiles](#) or the [GAIA Webs](#). What are the main advantages of **Sweden**? And what are its main weaknesses?

The position of **Austria** in the **GAIA** plane is more central. It is also the top ranked action in the **PROMETHEE** rankings. How do you explain that?



GAIA Plane

Exercises

Exercise P1

What is the **PROMETHEE II** ranking for the following weights:

$$w_{\text{Power}} = 50 \quad w_{\text{Manpower}} = w_{\text{Construction}} = w_{\text{Operation}} = w_{\text{Villages}} = w_{\text{Safety}} = 10$$

Exercise P2

What is the **PROMETHEE II** ranking for the following weights:

$$w_{\text{Villages}} = 5.5 \quad w_{\text{Manpower}} = w_{\text{Power}} = w_{\text{Construction}} = w_{\text{Operation}} = w_{\text{Safety}} = 1$$

Exercise P3

What is the **PROMETHEE II** ranking for the following weights:

$$w_{\text{Power}} = w_{\text{Safety}} = 5 \quad w_{\text{Operation}} = 4 \quad w_{\text{Manpower}} = w_{\text{Construction}} = w_{\text{Villages}} = 1$$

Exercise P4

Set all preference functions to the “Usual” type and compare the **PROMETHEE I** and **II** rankings (with equal weights).

Exercise P5

Starting from the initial data, change $f_2(a_2)$ to 100, $f_4(a_2)$ to 2 and $f_6(a_2)$ to 8. What is the new **PROMETHEE II** ranking ? Does it conform to your prediction?

Exercise P6

Using the [Walking Weights](#) display, progressively increase the weight of the **Power** criterion (f_2) up to 7. Look at the π [decision axis](#) in the **GAIA** plane. What is finally the best action?

Exercise P7

Use the following weight distribution to build a new **PROMETHEE II** ranking:

$$w_{\text{Manpower}} = 1 \quad w_{\text{Power}} = 5 \quad w_{\text{Construction}} = 1 \quad w_{\text{Operation}} = 4 \quad w_{\text{Villages}} = 1 \quad w_{\text{Safety}} = 5$$

Exercise P8

Move the decision axis in order to rank **Germany** as the best choice. (It is not easy!)

Hypermarkets

The context

A large US distribution company wants to develop a network of hypermarkets in Belgium. 12 potential locations are considered: 2 in the region of **Antwerp**, 3 in the region of **Bruges**, 4 in the region of **Brussels** and 3 in the region of **Namur**.

Antwerp and **Brussels** are large cities, where construction costs are high, space is scarce, but many potential customers are available. On the contrary, **Bruges** and **Namur** are smaller cities, with more space available and lower construction costs.

Five evaluation criteria are considered: **construction** cost expressed in millions of Euros, potential **customers** (thousands), number of **parking** places available, **access** to the road network (qualitative 1 to 6 scale), and the number of close **competitors**.

The actions

Twelve locations:

- a_1 : **Antwerp1**
- a_2 : **Antwerp2**
- a_3 : **Bruges1**
- a_4 : **Bruges2**
- a_5 : **Bruges3**
- a_6 : **Brussels1**
- a_7 : **Brussels2**
- a_8 : **Brussels3**
- a_9 : **Brussels4**
- a_{10} : **Namur1**
- a_{11} : **Namur2**
- a_{12} : **Namur3**

The criteria

- f_1 : **Construction** cost
- f_2 : **Population**
- f_3 : **Parking**

- f_4 : Road Access
- f_5 : Competitors

The model

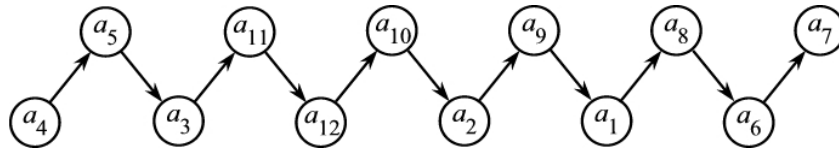
Some criteria are to maximize, others are to minimize. [Preference functions](#) and [weights](#) have been associated to the [criteria](#).

All the data are given in the next table.

Visual PROMETHEE Business - Hypermarkets.vpg (saved)						
File Edit Model Control PROMETHEE-GAIA GDSS GIS Custom Assistants Snapshots Options Help						
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Scénario1	Construction	Population	Parking	Access	Competitors
	Unit	M€	thousands	places	1 to 5	
	Cluster/Group	◆	◆	◆	◆	◆
[-]	Preferences					
	Min/Max	min	max	max	max	min
	Weight	3.00	1.00	1.00	1.00	2.50
	Preference Fn.	Linear	Gaussian	Gaussian	Level	V-shape
	Thresholds	absolute	absolute	absolute	absolute	absolute
	- Q: Indifference	0.5	n/a	n/a	1.5	n/a
	- P: Preference	3.2	n/a	n/a	2.5	3
	- S: Gaussian	n/a	75	225	n/a	n/a
[-]	Statistics					
	Minimum	4.9	45	200	2.0	0
	Maximum	21.3	755	1050	5.0	6
	Average	13.8	352	721	3.2	3
	Standard Dev.	5.7	231	224	1.1	2
[-]	Evaluations					
<input checked="" type="checkbox"/>	Antwerp1	21.0	425	500	2.0	1
<input checked="" type="checkbox"/>	Antwerp2	21.3	475	522	2.0	0
<input checked="" type="checkbox"/>	Bruges1	8.2	120	860	5.0	2
<input checked="" type="checkbox"/>	Bruges2	6.6	45	722	3.0	1
<input checked="" type="checkbox"/>	Bruges3	4.9	52	1050	4.0	3
<input checked="" type="checkbox"/>	Brussels1	21.3	755	850	3.0	5
<input checked="" type="checkbox"/>	Brussels2	17.9	625	200	2.0	5
<input checked="" type="checkbox"/>	Brussels3	17.3	524	780	2.0	5
<input checked="" type="checkbox"/>	Brussels4	14.2	540	690	4.0	6
<input checked="" type="checkbox"/>	Namur1	10.4	80	675	4.0	3
<input checked="" type="checkbox"/>	Namur2	12.9	310	786	5.0	2
<input checked="" type="checkbox"/>	Namur3	9.6	275	1020	2.0	3
All Scénario1						
Actions: 12 (12 active) Criteria: 5 (5 active) Scenarios: 1 (1 active) Locale: Belgium [€/.] Saved						

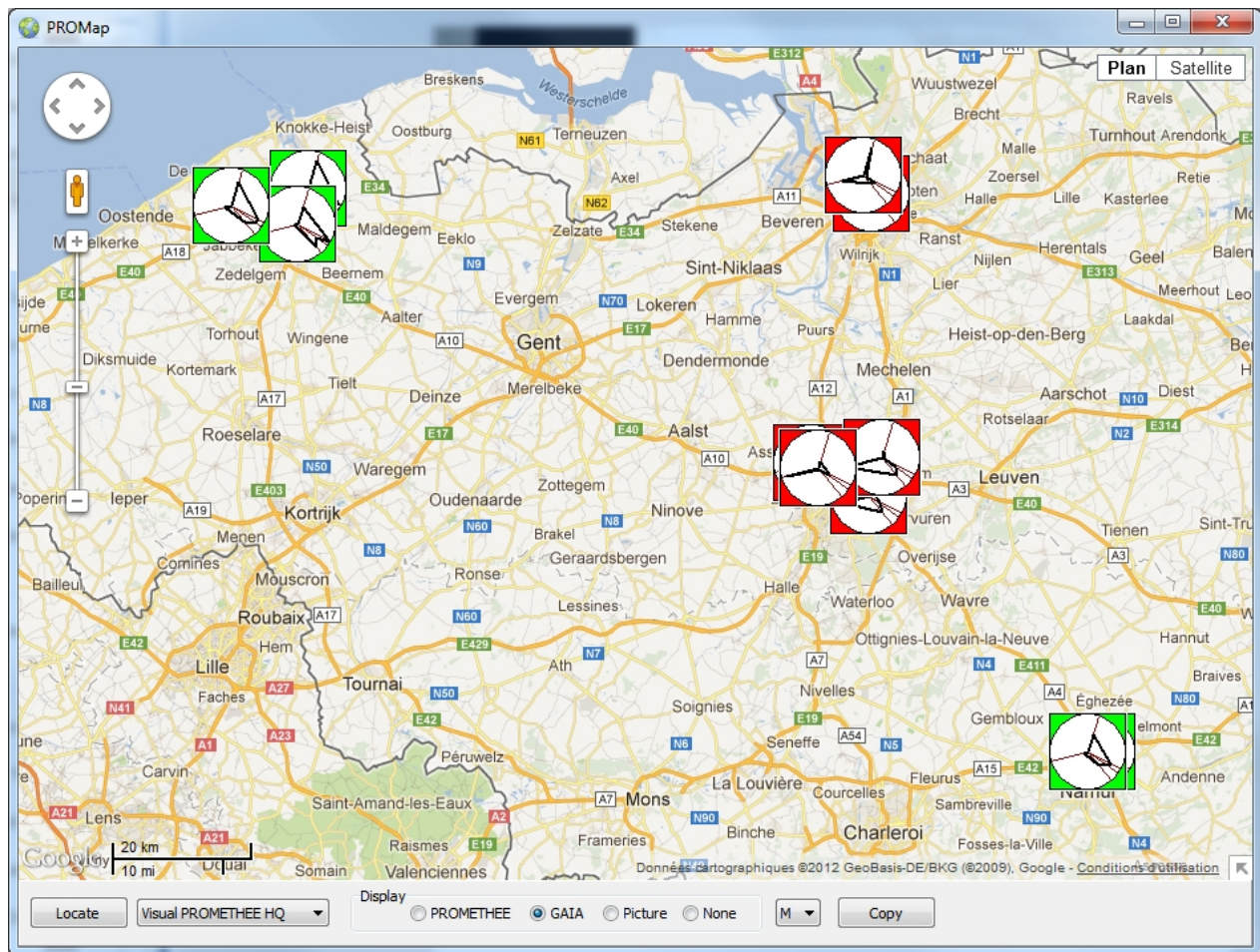
The analysis

The **PROMETHEE I** partial ranking doesn't include any particularly important incomparabilities. The **PROMETHEE II** ranking is more interesting:



PROMETHEE II Complete Ranking

The twelve locations are almost perfectly ranked by city: the three **Bruges** sites (a_4 , a_5 and a_3) are ranked first, followed by the ones in **Namur** (a_{11} and a_{12}), finally we find the ones in **Antwerp** and in **Brussels**. This can be explained by the specific geographical characteristics of each city.

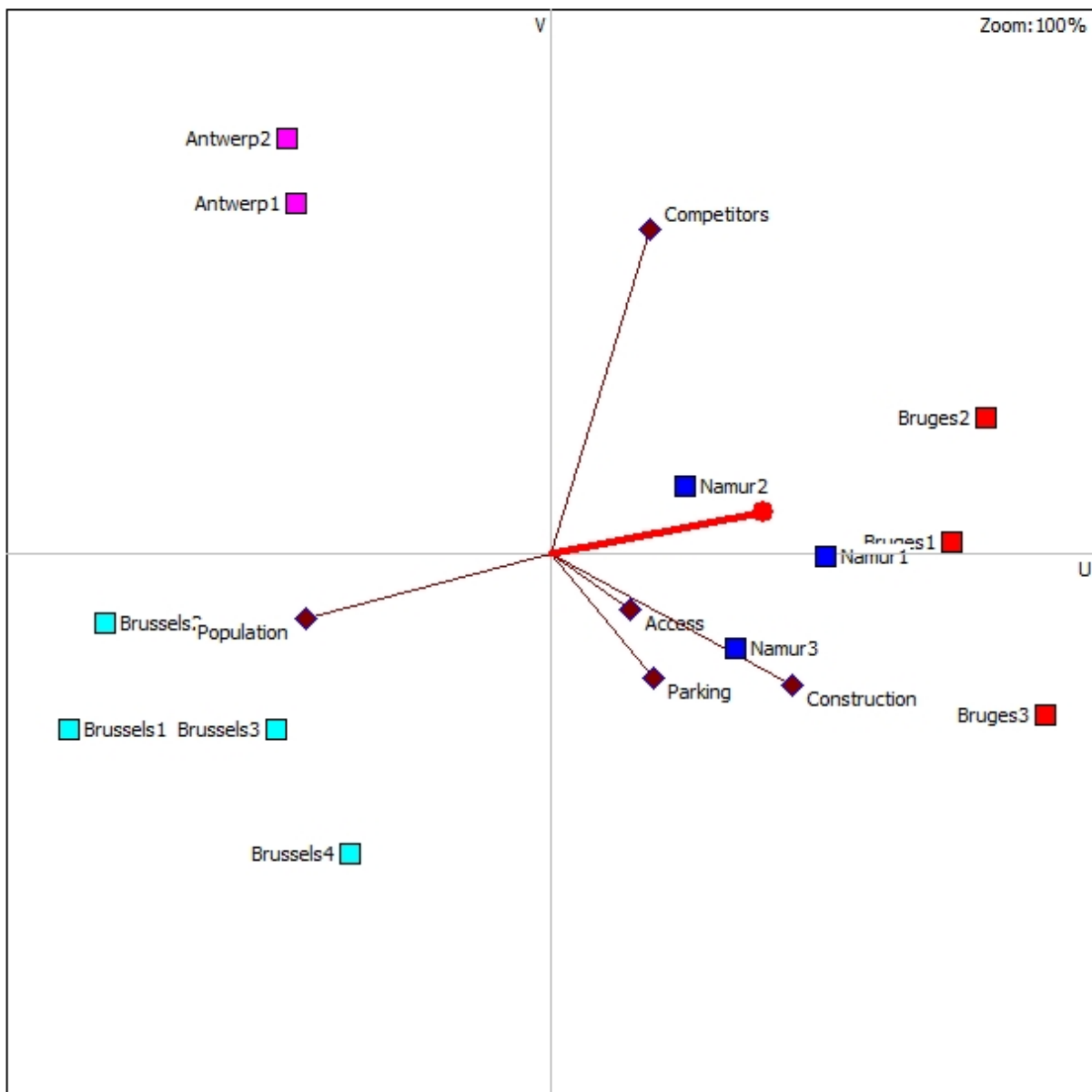


PROMap Display

The **GAIA** plane retains 86% of the information. It is thus particularly reliable. Criterion f_2 (**Population**) shows a large discriminating power (longer axis) and is strongly conflicting with most other criteria. On the other hand, **Construction** (f_1), **Parking** (f_3) and road **Access** (f_4) are expressing similar preferences. The geographical characteristics of the cities are confirmed. Indeed the actions appear to be geographically grouped in four clusters:

- **Bruges** on the right side of the plane: these are good solutions for **Construction**, **Access** and **Parking**.
- **Namur** closer to the center of the plane: these are more "medium" solutions.
- **Antwerp** at the top left of the plane: these are good solutions for **Competitors** and **Population**.
- **Brussels** at the bottom left of the plane: these are good solutions for **Population** (Brussels is the

largest city, but it is quite expensive, crowded and there are a lot of competitors there).



GAIA Plane

If the company were to select a single location, it should of course select it in the region of **Bruges**.

Actually the problem is not a single selection problem: the company wants to develop a nationwide network including several locations. It would be therefore absurd to make the selection on the sole basis of the **PROMETHEE II** ranking. Indeed the first six sites would be competing with each others in the **Bruges** and **Namur** regions while the **Brussels** and **Antwerp** regions wouldn't be covered.

A better solution is provided by [PROMETHEE V](#) taking into account additional selection constraints:

- The company wants to select between 5 and 9 sites. These values are entered in the **PROMETHEE V** constraints window as the Minimum and Maximum number of actions to select.
- Eight more constraints are introduced in the **PROMETHEE V** spreadsheet:
 - **Global return**: The management aims at a global expected annual return of at least 4000 k€ (individual annual returns are estimates in k€)
 - **Total manpower**: The total manpower should be at least 500.

- **Antwerp=1**: Exactly one of the selected sites should be in **Antwerp**.
- **Bruges<=2**: Maximum two sites are allowed to be selected in **Bruges**.
- **Brussels>=2**: At least two sites should be selected in **Brussels** as it is the largest city in the country.
- **Namur>=1**: At least one site should be selected in **Namur**.
- **ExclBrussels**: The sites **Brussels2** and **Brussels4** are located very close to each other. They cannot be selected together as they would directly compete with each other. However the management wants the company to be present in that area: one of the two sites should be selected.
- **ExclNamur**: A similar constraint is expressed for **Namur2** and **Namur3**.

5 PROMETHEE V

Constraints Solution

Number of actions to select: Minimum: 5 Maximum: 9

Constraints Add Delete

	A1	A2	B1	B2	B3	Bs1	Bs2	Bs3	Bs4	N1	N2	N3		
Net Flow	-0.1840	-0.0917	0.3266	0.3535	0.3434	-0.3361	-0.3649	-0.2744	-0.1713	0.0611	0.1771	0.1609		
<input checked="" type="checkbox"/> Global return	426.00	645.00	76.00	226.00	275.00	822.00	1026.00	692.00	601.00	464.00	516.00	602.00	>=	4000.00
<input checked="" type="checkbox"/> Total manpower	118.00	130.00	85.00	61.00	52.00	152.00	180.00	130.00	151.00	66.00	76.00	50.00	>=	500.00
<input checked="" type="checkbox"/> Antwerp=1	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	=	1.00
<input checked="" type="checkbox"/> Bruges<=2	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<=	2.00
<input checked="" type="checkbox"/> Brussels>=2	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	>=	2.00
<input checked="" type="checkbox"/> Namur>=1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	>=	1.00
<input checked="" type="checkbox"/> ExclBrussels	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	=	1.00
<input checked="" type="checkbox"/> ExclNamur	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	=	1.00

According to these constraints the **PROMETHEE V** selection is given below. It includes the seven following sites:

Antwerp2, Bruges2, Bruges3, Brussels1, Brussels2, Namur1 and Namur3

for a total net flow value equal to 0.1260

5 PROMETHEE V

Constraints Solution

Status: Done! Reset ☐ Display PROMETHEE II Ranking

Actions	Net Flow	Optimal	Compare	Constraints	Optimal	Compare
	Total:	0.1260	0.1260		LHS	RHS
Antwerp1	-0.1840	no	no	Minimum	7.00	>= 5.00
Antwerp2	-0.0917	yes	yes	Maximum	7.00	<= 9.00
Bruges1	0.3266	no	no	Global return	4060.00	>= 4000.00
Bruges2	0.3535	yes	yes	Total manpower	691.00	>= 500.00
Bruges3	0.3434	yes	yes	Antwerp=1	1.00	= 1.00
Brussels1	-0.3361	yes	yes	Bruges<=2	2.00	<= 2.00
Brussels2	-0.3649	yes	yes	Brussels>=2	2.00	>= 2.00
Brussels3	-0.2744	no	no	Namur>=1	2.00	>= 1.00
Brussels4	-0.1713	no	no	ExclBrussels	1.00	= 1.00
Namur1	0.0611	yes	yes	ExclNamur	1.00	= 1.00
Namur2	0.1771	no	no			
Namur3	0.1609	yes	yes			

Notice that the **PROMETHEE V** selection doesn't correspond to the top of the **PROMETHEE II** ranking.

Exercises

Exercise H1

What is the **PROMETHEE I** ranking for this problem?

Exercise H2

If the preference function associated to f_4 is changed to the Level type with $q = 1.5$ and $p = 2.5$, is the **PROMETHEE II** ranking modified?

Exercise H3

What is the **PROMETHEE II** first ranked location when the weight of criterion f_2 is increased from 1 to 10? Is this what you were expecting?

Exercise H4

Progressively increase the weight of the **Population** criterion (f_2). What is the minimum weight required to put a **Brussels** location at the top of the **PROMETHEE II** ranking?

Exercise H5

Starting from the initial weight distribution, increase now the weight of the **Competitors** criterion (f_5). For a value of $w_5 = 5$, is **Antwerp** leading the ranking?

Exercise H6

Find a weight distribution such that the decision axis is almost orthogonal to the **GAIA** plane.

Exercise H7

Use the **PROMETHEE V** "Compare" function to compare the optimal selection to:

1. the selection of the seven **PROMETHEE II** top-ranked sites,
2. the selection of the **PROMETHEE II** best-ranked sites in each city (one in Antwerp, two in Bruges, two in Brussels and two in Namur).

Cars

The context

A decision aid professor wants to purchase a new car. He hesitates between six models and has identified six criteria in order to compare these models. Most are technical criteria but they of course include the **Price** of the car as well as **Prestige** criterion.

The actions

Six models:

- a_1 : **Small 1**
- a_2 : **BMW 700**
- a_3 : **Audi A4**
- a_4 : **Volvo**
- a_5 : **VW Golf**
- a_6 : **Small 2**

The criteria

- f_1 : **T1** - a technical criterion
- f_2 : **Price**
- f_3 : **T2** - a technical criterion
- f_4 : **T3** - a technical criterion
- f_5 : **Prestige**
- f_6 : **T4** - a technical criterion

The model

Some criteria are to maximize, others are to minimize. [Preference functions](#) and [weights](#) have been associated to the [criteria](#).

All the data are given in the next table.

Visual PROMETHEE Business - Cars.vpg (saved)

File Edit Model Control PROMETHEE-GAIA GDSS GIS Custom Assistants Snapshots Options Help

Unit Cluster/Group Preferences Statistics Evaluations

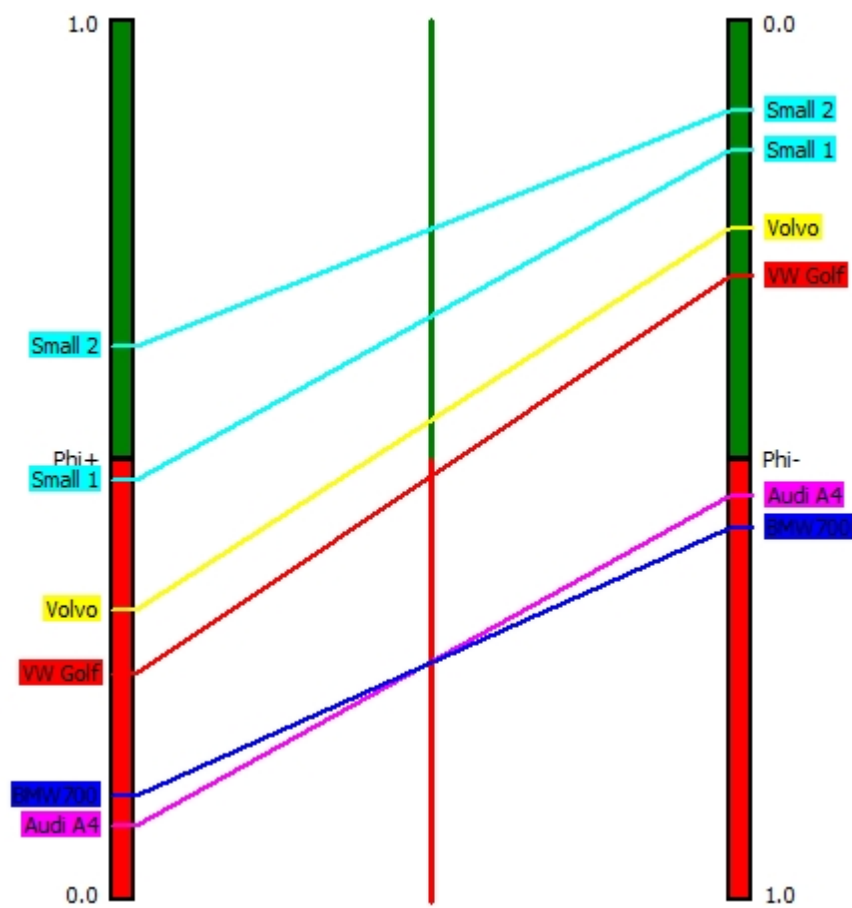
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
	JPB	T1	Price	T2	T3	Prestige	T4
Unit	unit	unit	unit	unit	unit	unit	unit
Cluster/Group	◆	◆	◆	◆	◆	◆	◆
Preferences							
Min/Max	min	min	min	min	min	max	max
Weight	1.00	15.00	1.00	1.00	1.00	1.00	1.00
Preference Fn.	U-shape	V-shape	Linear	Level	Usual	Gaussian	
Thresholds	absolute	absolute	absolute	absolute	absolute	absolute	absolute
- Q: Indifference	10.00	n/a	50.00	1.00	n/a	n/a	n/a
- P: Preference	n/a	30.00	500.00	6.10	n/a	n/a	n/a
- S: Gaussian	n/a	n/a	n/a	n/a	n/a	n/a	5.00
Statistics							
Minimum	40.00	4.00	200.00	2.00	20.00	1.00	
Maximum	94.00	42.00	1000.00	9.70	90.00	56.00	
Average	69.00	24.00	583.33	5.90	53.33	14.50	
Standard Dev.	18.65	14.19	247.77	2.56	23.57	18.77	
Evaluations							
<input checked="" type="checkbox"/> Small 1	80.00	10.00	600.00	5.40	20.00	5.00	
<input checked="" type="checkbox"/> BMW 700	65.00	42.00	200.00	9.70	90.00	1.00	
<input checked="" type="checkbox"/> Audi A4	83.00	40.00	400.00	7.20	60.00	7.00	
<input checked="" type="checkbox"/> Volvo	40.00	20.00	1000.00	7.50	30.00	10.00	
<input checked="" type="checkbox"/> VW Golf	52.00	28.00	600.00	2.00	70.00	8.00	
<input checked="" type="checkbox"/> Small 2	94.00	4.00	700.00	3.60	50.00	56.00	

All JPB

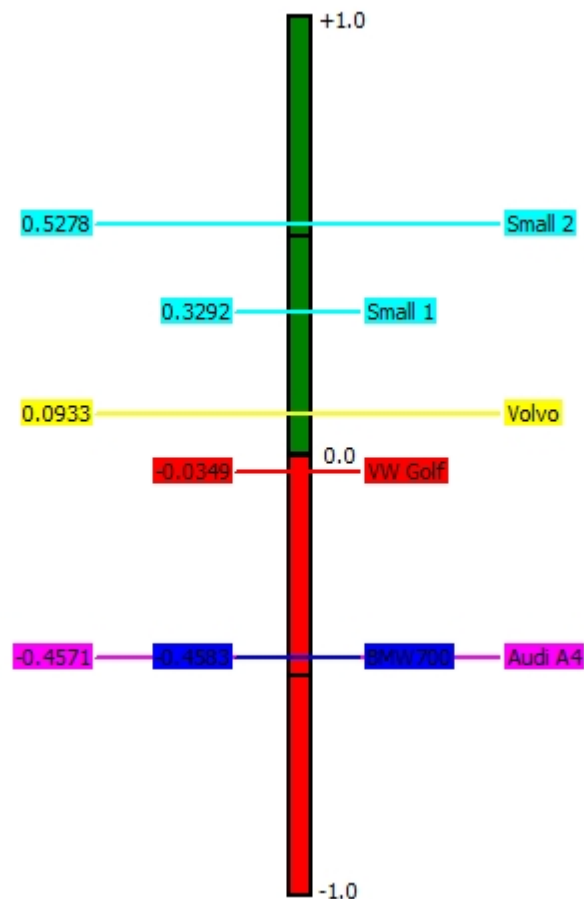
Actions: 6 (6 active) Criteria: 6 (6 active) Scenarios: 1 (1 active) Locale: Belgium [€/.] Saved

The analysis

Much weight has been given to the **Price** criterion and the **Small** cars that are much cheaper than the others are clearly at the top of the **PROMETHEE** rankings.



PROMETHEE I Partial Ranking



PROMETHEE II Complete Ranking

Exercises

Exercise C1

Analyze the **GAIA** plane.

Exercise C2

Lower progressively the weight of the **Price** criterion and observe the changes in the **PROMETHEE** rankings.

Exercise C3

Increase progressively the weight of the **Prestige** criterion and observe the changes in the **PROMETHEE** rankings.

CUV

The context

Another decision aid professor wants to purchase a new car: a compact utility vehicle (CUV) to replace his Mazda RX8. It is a big change and he hesitates between different models available on the Belgian market. He has identified six criteria in order to compare these models. Contrarily to the previous examples these are actual data from 2012 and the problem is also an actual one.

The actions

24 CUV models available on the Belgian market at the time of the Brussels *Salon de l'Auto* in January 2012.

The criteria

- f_1 : **Price**, in € (professors are no rich people).
- f_2 : **Power**, in kW (power welcome).
- f_3 : **Gas efficiency**, in L/100km (gas is money).

- f_4 : **CO₂ emission**, in g/km (green... OK, if it is British Racing Green...)
- f_5 : **Length**, in centimeters (I prefer larger cars).
- f_6 : **Trunk size**, in dm³ (need space to move).

The model

Some criteria are to maximize, others are to minimize. [Preference functions](#) and [weights](#) have been associated to the [criteria](#).

All the data are given in the next table.

Visual PROMETHEE Business - CUV2012.vpg (saved)							
File Edit Model Control PROMETHEE-GAIA GDSS GIS Custom Assistants Snapshots Options Help							
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Bertrand	Price	Power	Gas efficiency	CO2 emission	Length	Trunk
	Unit	€	kW	L/100km	g/km	cm	dm ³
	Cluster/Group						
	Preferences						
	Min/Max	min	max	min	min	max	max
	Weight	25.00	20.00	25.00	10.00	10.00	10.00
	Preference Fn.	Linear	Linear	V-shape	V-shape	Linear	Linear
	Thresholds	absolute	absolute	absolute	absolute	absolute	absolute
	- Q: Indifference	500 €	5	n/a	n/a	5	50
	- P: Preference	2,500 €	15	1.0	30	20	150
	- S: Gaussian	n/a	n/a	n/a	n/a	n/a	n/a
	Statistics						
	Evaluations						
<input checked="" type="checkbox"/>	Mazda CX5		36,900 €	129	4.5	119	456
<input checked="" type="checkbox"/>	VW Tiguan		34,360 €	127	6.3	165	443
<input checked="" type="checkbox"/>	BMW X3		41,950 €	135	5.6	149	550
<input checked="" type="checkbox"/>	Audi Q3		37,000 €	130	5.9	156	438
<input checked="" type="checkbox"/>	Audi Q5		38,900 €	105	6.2	162	540
<input checked="" type="checkbox"/>	BMW X1		32,900 €	105	5.7	150	445
<input checked="" type="checkbox"/>	Chevrolet Captiva		34,250 €	135	6.6	174	467
<input checked="" type="checkbox"/>	Citroën C-Crosser		35,550 €	115	7.2	175	510
<input checked="" type="checkbox"/>	Dacia Duster		17,350 €	81	5.3	137	475
<input checked="" type="checkbox"/>	Ford Kuga		31,900 €	120	6.1	159	360
<input checked="" type="checkbox"/>	Honda CRV		34,250 €	110	6.5	171	n/a
<input checked="" type="checkbox"/>	Hyundai ix35		33,540 €	100	5.5	149	465
<input checked="" type="checkbox"/>	KIA Sportage		29,990 €	100	5.5	147	564
<input checked="" type="checkbox"/>	Land Rover Freelander		29,750 €	110	6.2	165	755
<input checked="" type="checkbox"/>	Mercedes GLK		44,800 €	150	6.1	159	450
<input checked="" type="checkbox"/>	Nissan Qashqai		29,550 €	110	7.0	184	410
<input checked="" type="checkbox"/>	Opel Antara		34,000 €	135	6.6	175	420
<input checked="" type="checkbox"/>	Peugeot 4007		39,950 €	120	6.7	175	463
<input checked="" type="checkbox"/>	Renault Koleos		34,600 €	127	6.4	166	450
<input checked="" type="checkbox"/>	Skoda Yeti		27,545 €	103	6.0	157	405
<input checked="" type="checkbox"/>	Ssangyong Korando		26,490 €	129	6.4	169	486
<input checked="" type="checkbox"/>	Suzuki Gran Vitara		27,950 €	95	7.0	179	398
<input checked="" type="checkbox"/>	Toyota RAV4		28,400 €	110	5.8	159	469
<input checked="" type="checkbox"/>	Volvo XC60		37,550 €	120	5.7	149	490
All Bertrand							
Actions: 24 (24 active) Criteria: 6 (6 active) Scenarios: 1 (1 active) Locale: Belgium [€/.] Saved							

The analysis

The **GAIA** plane inspection shows that there are four groups of criteria:

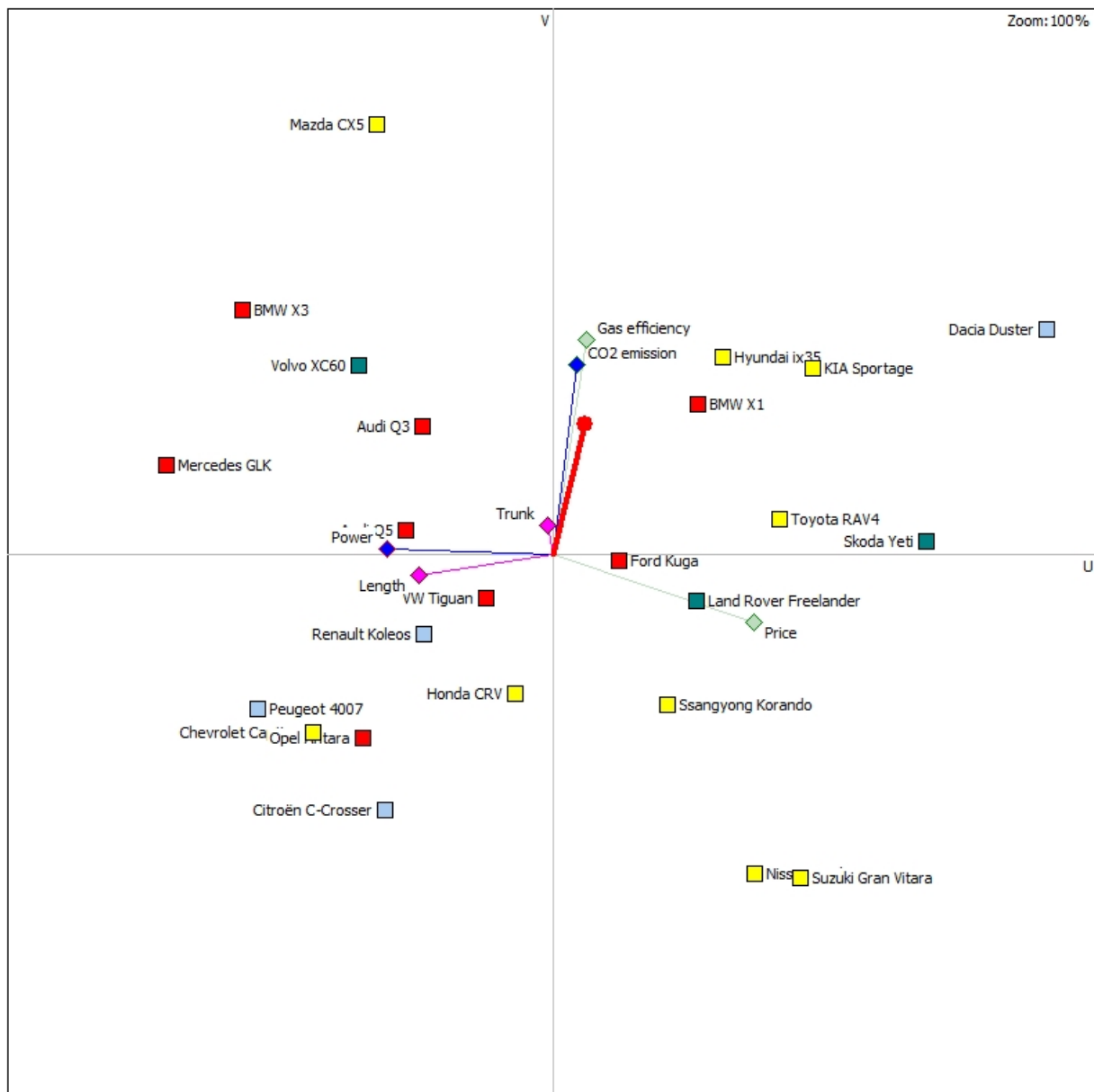
- **Power** and **Length** are oriented to the left. The more powerful cars are also the larger ones.
- **Gas efficiency** and **CO₂ emission** are oriented to the top. A better gas efficiency means less CO₂ emissions.
- **Price** is on its own and more or less opposite to all the criteria. If you want a large, powerful and gas efficient car, you will have to pay for it.
- **Trunk** has a very short axis. Indeed with the exception of one car that has a very large trunk (755 dm³), all the other are in the 360 dm³ to 564 dm³. Given that the preference threshold (p) for this criterion has been set equal to 150 dm³ and that there is an indifference threshold (q) equal to 50 dm³ this criterion is much less discriminating than the other ones.

Four action categories have been defined to better identify the cars according to their regional origin:

- German cars are represented in red.
- French cars are represented in blue.
- Asian cars are represented in yellow.
- Other cars are represented in green.

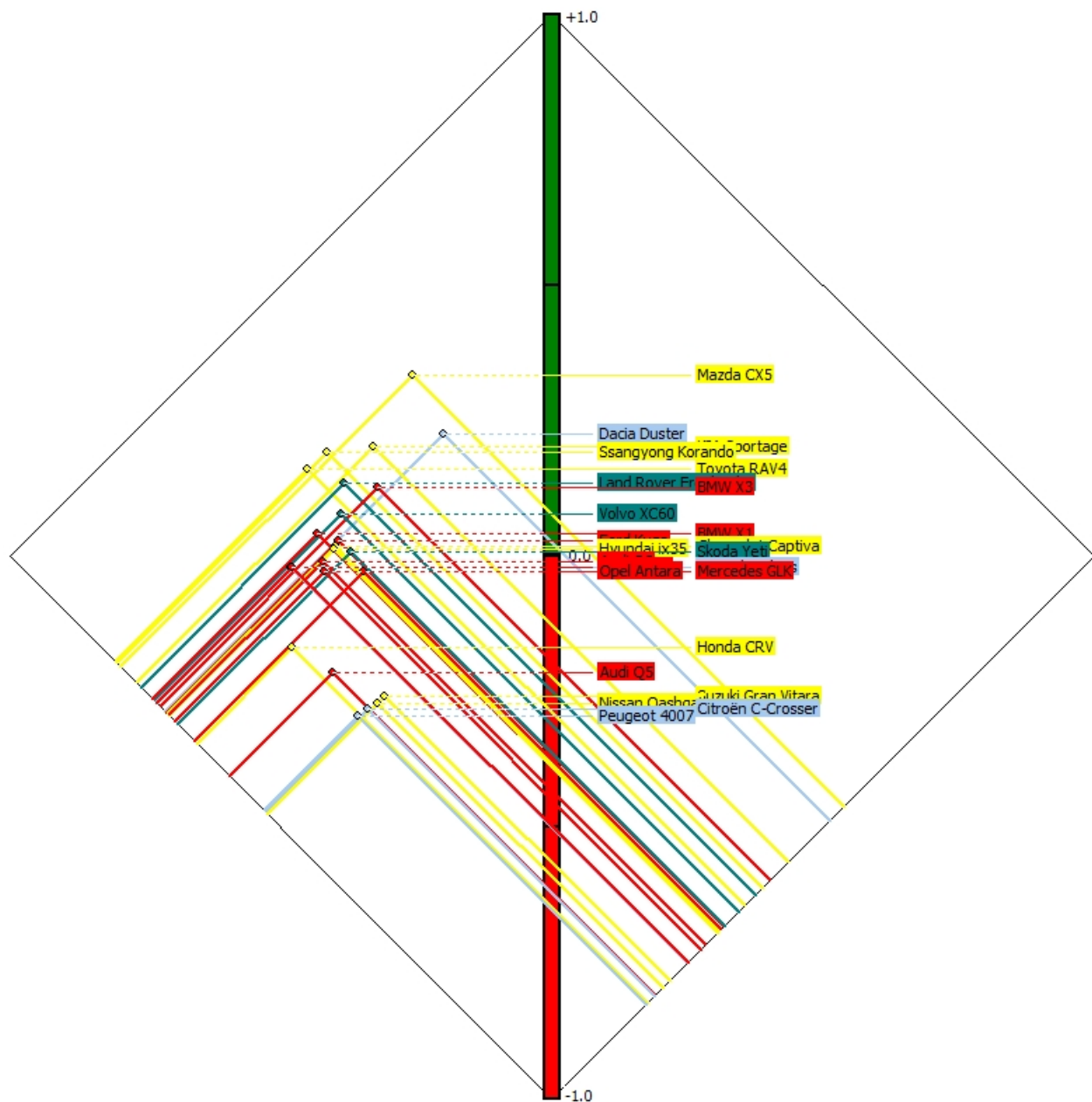
Regional groupings can be observed in the **GAIA** plane:

- German cars are more powerful and more expensive.
- French cars are grouped in the lower-left part of the plane, with the exception of the **Dacia Duster** that has a very special profile (low price and good gas efficiency).
- Asian cars are usually cheaper (the **Mazda CX5** is the full-options version) but show a wider spread over the plane thus providing the buyer with more diversified profiles.



GAIA Plane

The [PROMETHEE Diamond](#) shows the domination of a few Asian cars and of the **Dacia Duster** (it is much cheaper than the others). The **PROMETHEE I** incomparabilities emphasize the many different profiles provided by Asian manufacturers. The German cars are handicapped by higher prices and lag in the middle of the **PROMETHEE II** ranking. Overall the **Mazda CX5** is at the top.



PROMETHEE Diamond

Exercises

Exercise U1

Given that the **Trunk** criterion is not much discriminant, deactivate it and compare the **PROMETHEE II** with the original one. Are there many changes? Check the position of the car with the largest trunk. Is it what you were expecting?

Exercise U2

In what range can you change the weight of the **Trunk** criterion without changing the **PROMETHEE II** top-ranked car? Hint: Use the [Visual Stability Intervals](#) window and adjust the stability level to 1.

Exercise U3

Guess which car I am driving now!

Useful links

You can find additional information at:

- www.promethee-gaia.net
This is the official **PROMETHEE-GAIA** web site. Here you can find and exchange information related to the methods and their implementation:
 - blog.promethee-gaia.net
The **PROMETHEE Blog** with information about events related to the methods and the software.
 - forum.promethee-gaia.net
The **PROMETHEE-GAIA Forum** where people can exchange information and experience related to the methods, the software and their applications.
 - faq.promethee-gaia.net
The **PROMETHEE-GAIA FAQ** with questions and answers related to the methods and the software.
 - biblio.promethee-gaia.net
The **Bibliographical Database** with over 400 scientific references related to the **PROMETHEE** methods.
- www.decision-drive.com
This is the site dedicated to the business applications of the **PROMETHEE** methods.
- www.sustainable-decisions.com
This site is dedicated to the use of multicriteria methods in the context of sustainable development.
- The **LinkedIn** [PROMETHEE Decision Aid Methods group](#)
- **Twitter** at @bmaresc
- and more coming soon...