

# **MCDA Tool**

## User Guide



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## Outline

MCDA (Multi Criteria Decision Analysis) is a methodology to support decision making with the benefit of, simply put, being capable to compare apples and oranges. For the goal to choose one alternative out of a set of several ones, users can interactively define firstly the criteria to be considered and secondly their impact respectively weight when considered. This interactive process is often used when decision makers try to find a stable agreement that can be accepted by all members of the group. Frequently, having a structured discussion on the decision to be made is actual the greatest benefit of the whole MCDA process.

The MCDA tool covered by this guide was originally developed by the Institute for Nuclear and Energy Technologies (IKET) that is part of the Karlsruhe Institute of Technology [KIT]. While there are many different variants of MCDA, the MCDA tool developed by KIT focusses on a normalized and weighted sums of criteria.

## Note

At the time of writing this document the MCDA tool provides already a great amount of functionality and is used in many scientific projects as showcase for the potential use of the MCDA methodology. It is considered to be stable in most of its parts.



Nevertheless, it is not a commercial application. It is a scientific tool and continuously improved. Therefore, it may contain bugs, especially in recently added functionality. It is recommended to create backups of your important analyses when upgrading to a more recent version. Also you may want to check for updates regularly. Finally, if you encounter a bug, feedback is appreciated to improve the stability of the application in the future.

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# 1. Introduction

During creation of this document an unofficial download page was set up providing basic information and access to the software. This page has become more and more official and a stable location to access the most recent development. Special questions or requests for the software should be directed to KIT, namely Tim Müller (Tim.Mueller@kit.edu) or Wolfgang Raskob (Wolfgang.Raskob@kit.edu). The web presence is provided at <https://portal.iket.kit.edu/MCDA/> and a public community collaboration project may be established at some time, maybe even using a platform similar to sourceforge or github.

## 1.1 Requirements

The MCDA Tool is completely written in Java and requires a Java Runtime Environment (JRE) when used. Therefore the software is basically operation system independent and can be used on any computer operated by Windows, Linux, Mac, etc that supports Java 11 or up. The application itself neither requires high computation power nor a large amount of memory, with probably the one exception of *very large* ensemble evaluations in the range of millions.

If no JRE is installed on the target PC several compatible implementations are available on the internet. The most common JRE is provided by Oracle and can be downloaded from their website [JRE], but others are also suitable like e.g. the Zulu OpenJDK binaries which we tested as an alternative. The installation of a JRE is usually straightforward. Simply follow the instructions of the according website or installation wizards.

For convenience, we provide downloads bundled with a Zulu JRE for Windows and Linux. For Linux the executable bit has to be set on the binaries in the bin folder of the bundled JRE (e.g. `chmod +x bundled-jre-folder/bin/*`).

## 1.2 Installation and Start

The installation of the MCDA Tool is very easy: download and unzip the software in a directory of your choice. Switch into the newly created directory named MCDA-vX.Y-build(ABCD), where X, Y, and ABCD are numbers according to the current version. On most systems a double click on MCDA.jar or the scripts start.bat respectively start.sh should launch the application. The scripts can be customized if the use of a specific java version is desired. In rare circumstances you may have to run it manually in a command line window with the following command:  
`java -jar MCDA.jar`

Starting the MCDA application presents the wizard window. It allows to load an existing analysis or to create a new one from scratch supported by a guided process. The Wizard provides an easy starting point for new users. Therefore it simplifies and hides details from the user during the creation process. Once the general definition of the MCDA analysis is complete the main application is launched, which provides the full functionality for editing.

## 1.3 Points of Interest

The application is prepared to be multi-lingual. Up to now English and German are provided. Semi automatically generated translations of the report are available for Slovak, Spanish and Italian. New languages, even special wording can be easily integrated by users themselves. Help and proposals of translations are welcome. For details check out Appendix B: Localization.

All subcomponents follow the same concept and style. Icons and colours usually have the same meaning. The icons and colours can also easily be customized. For details check out Appendix C: Customization.

Many components of the user interface already provide a brief contextual help which is activated by hovering the mouse over it. More detailed help is available by clicking the help buttons which are available in several contexts. Most components also provide context menus. They are activated by clicking onto a graphical component using the second respectively right mouse button.

A global undo/redo is provided, yet not all operations can be automatically be undone. The analyses as well as parts of it like the weights can be stored as and restored from file. The format is XML thus allowing to edit it with text editors manually if necessary. For details check out Appendix D: File Format.

## **1.4 License**

The MCDA Tool is “open source” and free to use for non-commercial usage. The general goal is to wide-spread the tool and improve it in a collaborative manner in a scientific community therefore distribution and usage is explicitly welcome. However “making money” with it is subject to negotiation.

The specific licence is not yet fixed but is likely to be similar to the BSD [BSD] licence for non-commercial usage.

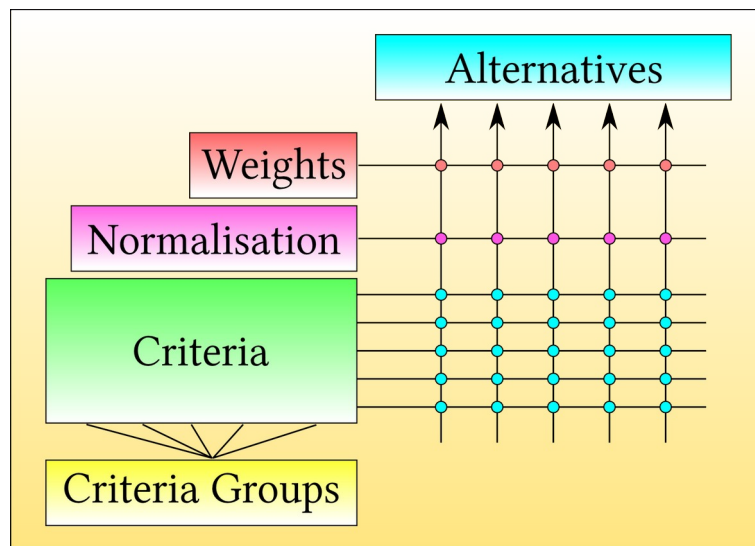


In general the MCDA application consistently provides context sensitive help. When in doubt hover the mouse over a graphical element like a button or a label. In many cases a helpful tooltip will appear. Also using the second mouse button on a graphical component often opens a context menu with additional functionality.

## 2. Basics of MCDA

Many different variants of Multi Criteria Decision Analysis (MCDA) are known. The following focusses on the method of the sums of normalized and weighted criteria as it is implemented in the MCDA tool of KIT. Performing this method can be roughly separated in two parts: firstly in the definition of the MCDA data structure followed by the input of the corresponding data values and secondly in the actual analysis with the help of different visualisation means.

The most simple form of MCDA boils down to a value matrix and computing weighted sums [Illustration 1]. For a given problem to be solved i.e. to choose one solution of a set of solutions, the columns of the matrix represent the set of available solutions of the problem and the rows represent the attributes or measurements that are taken into account to choose the “best” solution. In the further context of this document the problem is referenced to as **goal**, the solutions are referenced to as **alternatives** and the attributes are referenced to as **criteria**. Furthermore, not all criteria are equally important and therefore are fitted with an importance value referenced to as **weight**.



*Illustration 1: The basic concept and data structure of MCDA.*

The more criteria are used the more confusing it is to understand and organise the value matrix. Also in real life application many criteria belong to certain groups of criteria with a more general name (like different costs all belong to the general type cost). Therefore the MCDA tool provides means to organise the criteria in groups resulting in a treelike view to provide better understanding of the overall structure. In the following this is referenced to as **grouping**. Grouping is not really part of the actual MCDA method and just helps to clarify structures. The grouped structure is internally treated as plain matrix when evaluating the problem.

As many different criteria can be used e.g. costs, temperature, height but also vague measurements like public acceptance, social benefit, etc. they cannot be compared naturally. To make them comparable they all need to be on the same scale. This is called normalisation. Many normalisation methods are integrated in the MCDA tool already. Some of them need additional user interaction, but mostly they require common sense when being chosen from the available set. The final value for each alternative is the weighted sum of the normalised criteria values.



Therefore to use MCDA as a support tool to solve your specific problem, you need to identify your alternatives and criteria first and enter the according values into the MCDA tool. Afterwards you define the weights of the criteria.

### 3. In a rush...

This chapter explains the MCDA Tool by applying it to a simple use case. For the sake of speed no explanations are given and details are explained in the following chapters. As a result you can quickly define your own analysis, but may miss the full potential of the software.



A video for the following actions is available from the website or the help menu.

#### Use case

- Goal: you want to buy a car.
- Alternatives: Mercedes, BMW, Porsche
- Criteria: price to buy, maximum speed, fuel consumption
- Personal preference: speed is most important to you, price matters, consumption is almost neglectable. Accordingly you define the weights of the criteria to be 6, 4, and 1.

#### Wizard

1. Start the application: double click on MCDA.jar or type “java -jar MCDA.jar”
2. Select “Wizard”
3. Fill in the goal label “Buy a car”
4. Click “Next”
5. Click on any button with the icon “plus”
6. From top down, fill in the alternative labels “Mercedes”, “BMW”, “Porsche”
7. Click “Next”
8. Click on any button with the icon “plus”
9. From top down, fill in the criteria labels “Price”, “Speed”, “Consumption” and in the same order the criteria importance 4, 6, and 1.
10. Click “Next”
11. From top down, fill in the price values “50000”, “40000”, “80000”. In the row with “40000” click the “Best value” radio button.
12. Click “Next”
13. From top down, fill in the speed values “230”, “250”, “280”. In the row with “280” click the “Best value” radio button.
14. Click “Next”
15. From top down, fill in the consumption values “8.0”, “8.5”, “11”. In the row with “8.0” click the “Best value” radio button.
16. Click “Next”
17. Click “Finish”

## **Analysing and Editing**

According to the “Report”, “BMW” is ranked best but not with a large margin. The “Bar chart” shows all three cars ranked close. “Speed” contributes more to the overall weight than “Price”, but almost equally to all alternatives.

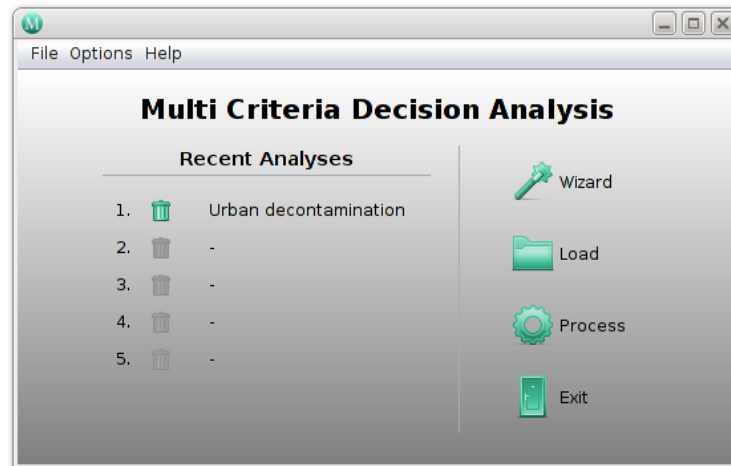
Open some charts from the menu entry “Analysis”→”Chart”. While charts are open, move the sliders of the weights, e.g. set the weight of “Price” to “1.0”. “Porsche” will now be ranked higher than “BMW”.

Assume you can get a Porsche for “60000” if you are lucky, for “80000” in general and for “90000” at most. In the “Values” window right click onto the “Porsche”-”Price” cell. From the combo box select “Triangular Distribution”. Enter the values “60000”, “90000”, “80000” and click “Show”, then “Save and Close”. The average is now “76666”. Set the weights back to the values “4.0”, “6.0”, “1.0”. “BMW” is still ranked highest.

Open the menu entry “Analysis”→”Ensemble”. For the number of samples enter “10000”. Click “Apply”. Click on tab “Ensemble 2”. The variance for the ensemble is very small and has no impact on the final ranking. Click on tab “Bar Chart”. From 10000 samples taken, “BMW” ranked best in all samples. In 66% of all samples taken, “Porsche” ranked second place and in 33% of all samples taken third place. Change the value for “Porsche”-”Price” back to constant “80000”. In the “Ensemble” window “Mercedes” is now ranked second place for 100% of all samples taken.

## 4. Getting started

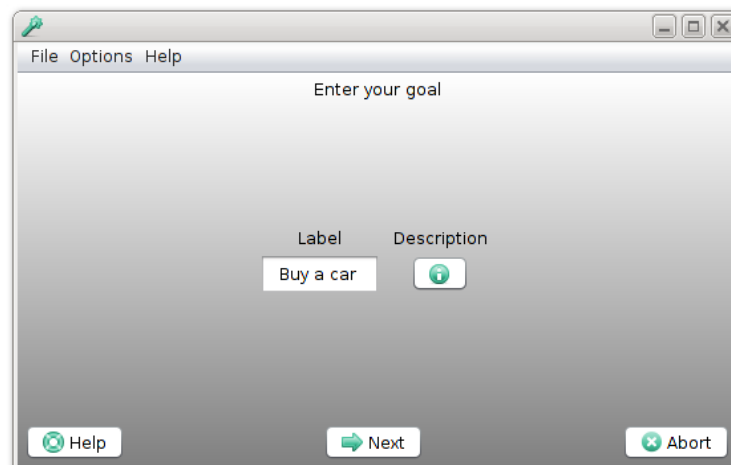
Starting the MCDA tool presents a window with different entry points to select from [Illustration 2]. It provides a list of recently processed problems and four buttons with different functions: to create a new MCDA in a guided process from scratch, to load an existing one from file, immediately process an existing one in the background without displaying the user interface, or to exit the application.



*Illustration 2: The greeting window of the MCDA Tool.*

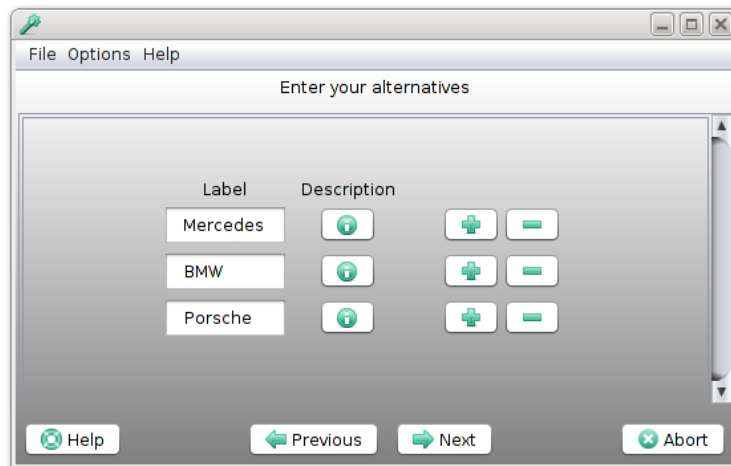
### 4.1 Creating a new MCDA

Clicking on the “Wizard” button will provide a guided process to create a new MCDA. In the unlikely event of a crash of the previous session the wizard will have created a progress backup during the process. In that case one has to initially choose if the previous content should be restored. Selecting “Yes” will restore the previous content, selecting “No” will start from scratch normally. Either way the wizard will continue and present a form to enter the basic information about your new project. The first thing to do is to enter the label and description of your goal [Illustration 3].



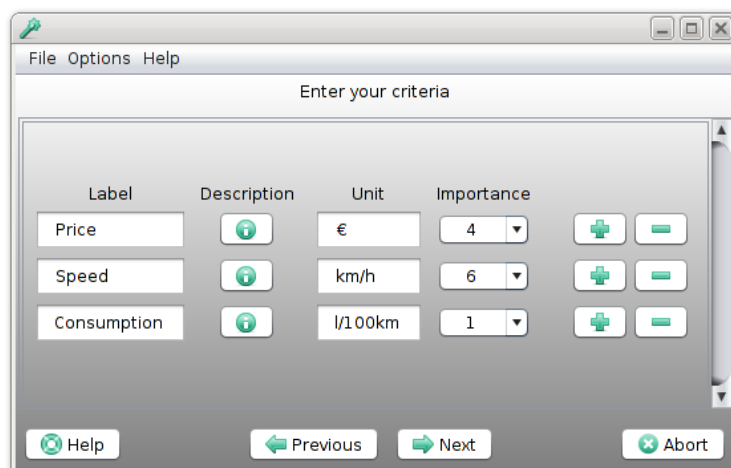
*Illustration 3: The definition of the goal.*

Click the next button to continue. The following form allows you to enter the set of alternatives [Illustration 4]. Each alternative has a label (preferably distinctive) which can be typed into the text field and a textual description. The description can be entered by clicking on the description button. Initially two alternatives are defined by default. Alternatives can be added by clicking on any add button of the rows and removed accordingly by clicking on the remove button in the corresponding row. At least two alternatives must be defined. Once the input is complete the next button has to be clicked to move on to the definition of criteria.



*Illustration 4: Entering alternatives in the wizard.*

The procedure to define criteria is basically identical to the way of defining alternatives [Illustration 5]. The only additional input to be defined is the weight respectively importance factor of each criterion. Values between 1.0 and 10.0 are allowed as input, 1.0 meaning least important and 10.0 meaning most important. Bear in mind that the importance factor is relative i.e. if two criteria are defined with importance factors 1.0 and 2.0 the second criterion is twice as important as the first one. In this example the importance factors of 5.0 and 10.0 have the same meaning and would lead to the exactly same result in the end. The next button allows you to move on to the first of a series of value input forms.



*Illustration 5: Entering criteria in the wizard.*

For each criterion an input form is presented where the values for each alternative have to be entered [Illustration 6]. As input any numerical value is allowed. As the values will be

normalised internally it is mandatory to establish a ranking on them. This is simply done by marking the “best” value and is usually either the maximum or minimum of the criterion, however not necessarily. It can also be one of the values between maximum and minimum. If multiple alternatives share the same best value any of these can be marked. The next button will lead to the input form of the next criterion. The next button of the input form of the last criterion will lead to the summary.

Alternatives	Values	Best value
Mercedes	50000	<input type="radio"/>
BMW	40000	<input checked="" type="radio"/>
Porsche	80000	<input type="radio"/>

*Illustration 6: Entering values and their ranking in the wizard.*

After completing the input of the criteria values a summary is presented allowing to briefly check for obvious mistakes [Illustration 7]. Clicking on the finish button closes the wizard window and opens the main window of the MCDA Tool.

Summary

Your goal is: Buy a car  
 You defined 3 alternatives.  
 You defined 3 criteria.

*Illustration 7: The input summary of the wizard.*

## 4.2 Loading an existing MCDA

To load an already existing MCDA either click on a recent analysis or on the load button of the initial window [Illustration 2]. While clicking on a recent analysis will directly open the main window the load button will open a file chooser first and the main window after selecting an appropriate MCDA file. The “examples” directory in the MCDA installation folder contains some example files.

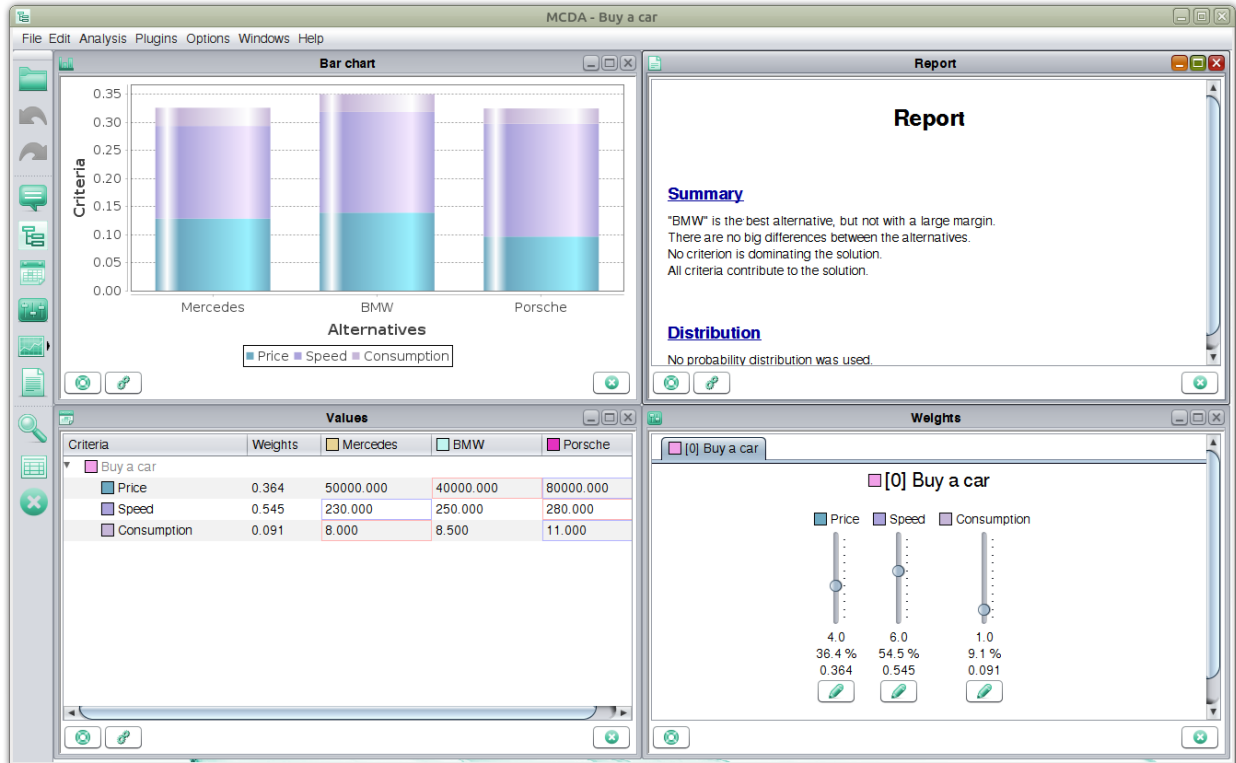
### **4.3 Directly processing an MCDA**

The MCDA Tool provides a shortcut to directly process an existing MCDA and to generate results as e.g. a HTML report. This is especially useful for evaluating ensembles.

The automatic ensemble evaluation is not working yet, however the evaluation within the GUI is available.

## 5. Working with the MCDA Tool

The MCDA application provides a single main window. All functionality of editing and analysing is accessible in this context [Illustration 8].



*Illustration 8: The main window of the MCDA tool.*

### 5.1 Main window

The main window contains the three important parts of the MCDA tool: the workspace, the menu bar and the tool bar.

#### Workspace

The largest part of the main window is covered by the workspace. It contains the internal windows of the various tools. The workspace allows handling of the windows like a common desktop. Windows can be moved, minimised, maximised, and closed. Some menu and tool bar entries allow manipulation of the windows like e.g. arranging them as tiles.

#### Menu bar

All available functions are accessible through the menu bar. In general the objective of each entry is obvious or is explained by its tooltip. While the tool bar contains only a selection of stable tools the menu bar allows access to all available tools even if they may not be considered stable yet. The menu bar is split in the following groups:

- **Menu File:** in this group all input and output functions are gathered. Besides creating, loading, and saving also the import and export of the MCDA is possible. It is worth to mention that it is possible to imported or exported only parts of the MCDA e.g. the definition of the weights may be stored separately. For this reason it is easy to combine



different setups of the same structure. Furthermore it is possible to export the report as HTML.

- **Menu Edit:** this group for one contains undo and redo functionality and also means to edit the defining parameters of the MCDA e.g. the meta information, the values, and the weights. Many actions of the editors can be undone and redone. However not all existing actions are covered yet, therefore it is advisable to keep backups of important projects. The tooltip of the undo respectively redo menu entry provides a hint of the action that will be performed when activated.
- **Menu Analysis:** this menu provides functions for analysing the structure and the behaviour of the MCDA. This starts from the very basic yet quite important visualisation methods like charts or tree graphs up to the verbalised report and deep analyses regarding stability or correlations. Some pie charts are still experimental and may not work as intended yet.
- **Menu Plugins:** this menu is reserved for menu entries of MCDA Tool extensions. It may be empty if no plugins are installed. Plugins can be created using the plugin framework. Example code as Netbeans [Netbeans] project is provided in the doc/plugins folder for demonstration purposes.
- **Menu Options:** some preferences can be customised using this menu, most notable the display language and the font size. Other preferences like window location or recently used folder when storing a MCDA are set implicitly and hidden from active management.
- **Menu Windows:** the functions from this menu interact with the windows on the workspace e.g. arrange them neatly or allow to bring a window from the background to the front.
- **Menu Help:** the entries in this menu provide access to the user guide, the video tutorial, and the log file as well as to the update check and information about the application itself.

## **Tool bar**

The tool bar contains a sub set of the MCDA functionality and provides quick access to the most commonly used tools. The icons are complemented with tooltips to better identify their objectives. Tool available from the toolbar are considered to be stable.

## **Internal windows**

In general using a function respectively starting a tool opens an internal window within the workspace. All windows share the same basic structure: decorations with title and buttons for minimising, maximising, and closing the the window, a main panel displaying the content and a button toolbar containing buttons for help, for options (if available), and for closing the window.

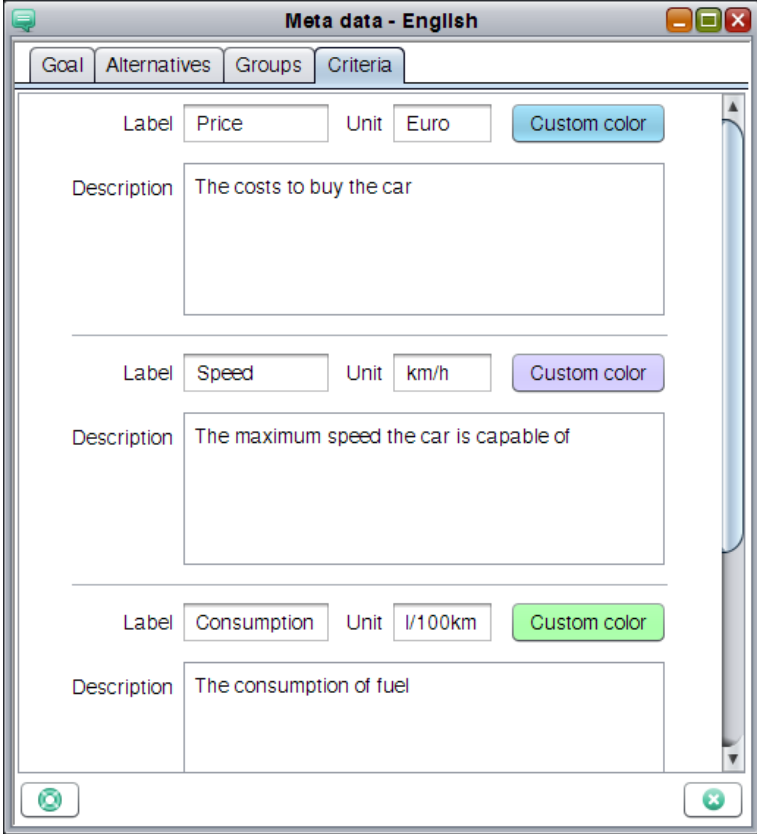
A set and arrangement of internal windows can be stored as a view to quickly access certain combinations of tools.

The tools integrated as internal windows are briefly presented in the following.

## 5.2 Editing

### Meta Data

The MCDA contains additional information addressed as meta data e.g. the label or description of the goal that is not required for the actual analysis. This data can be changed in the meta data view [Illustration 9].



The screenshot shows a window titled "Meta data - English" with four tabs: "Goal", "Alternatives", "Groups", and "Criteria". The "Criteria" tab is active. It displays three criteria, each with a "Label" text field, a "Unit" text field, a "Description" text area, and a "Custom color" button. The first criterion is "Price" with unit "Euro" and description "The costs to buy the car". The second is "Speed" with unit "km/h" and description "The maximum speed the car is capable of". The third is "Consumption" with unit "l/100km" and description "The consumption of fuel". The window has standard OS window controls and a scroll bar on the right.

*Illustration 9: The user interface to handle the meta data.*

The window provides four tabs each following the same structure: for the goal, the alternatives, the groups, and the criteria. The smaller text field holds the label of the entity. The larger text field holds the description of the entity that in general is shown as tooltip in other contexts. The coloured rectangle shows the custom colour of the entity that is used e.g. in charts to draw the entity. The custom colour can be changed by clicking onto the rectangle. For criteria an additional text field is available defining the unit of the values. Units are not evaluated but simply displayed to help understanding the meaning of values.



Text entered into the fields is specific to the currently selected language, allowing the localised presentation of the MCDA problem. For example, if the German language is selected changing the label of the goal will be stored as German label. Switching the language for the application to English afterwards will show the label stored for English. If no text is available for the selected language the default is taken, the default being the first text ever entered. The currently selected language is displayed in the title of the window for convenience.

## Values

The window of this tool displays the values and normalised values of the MCDA as well as its structure. The columns refer to the alternatives and the rows refer to the criteria. In the first column the criteria are displayed as a tree structure to reflect their arrangement in groups. Additionally in the second and third column the weights and AHP indicators are shown. Optionally the worst and best values of each criterion are marked in blue respectively in red. Also value functions like probability distributions may be marked with a small coloured icon if enabled in the options [Illustration 10].

Criteria	Weights	Mercedes	BMW	Porsche
Buy a car				
Fun	0.500			
Speed	0.300	230.000	250.000	280.000
Sound	0.200	75.000	70.000	105.000
Price	0.400	50000.000	40000.000	80000.000
Consumption	0.100	8.000	8.500	11.000

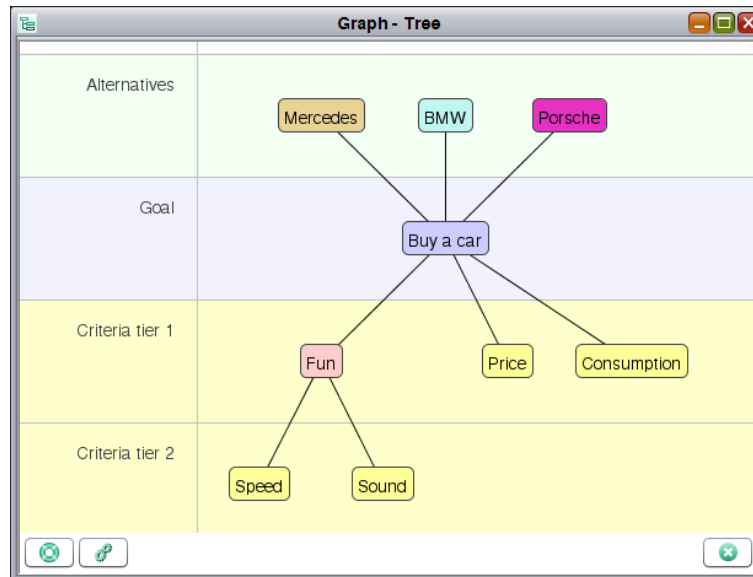
*Illustration 10: The value view displaying the matrix structure of the MCDA.*

To edit a value use the second mouse button click into the corresponding cell which opens a dialogue. Constant values can be defined as well as value functions. Normalised values, weights, and AHP indicator cannot be edited. Clicking on the column header will cause the rows to be sorted in ascending respectively in descending order. A click with the second mouse button opens a context menu to hide respectively show columns.

The tree structure also provides a context menu that can be accessed using the second mouse button. Depending on the underlying criterion or group the menu entries may differ. Amongst others the menu entries allow to add and remove criteria and groups as well as to open the normalisation editor for the underlying criterion. For usage of AHP see section Analytic hierarchy process (AHP) page 25. Last but not least the nodes in the tree can be dragged and dropped to rearrange the structure of criteria and groups.

## Graphs

The graphs window provides three different graphical displays of the MCDA structure: a classical tree view, a vertical MCDA view and a horizontal MCDA view. The actual type can be selected in the options dialogue triggered by the option button of the view [Illustration 11].



*Illustration 11: A MCDA with groups of different tiers presented in the tree view.*

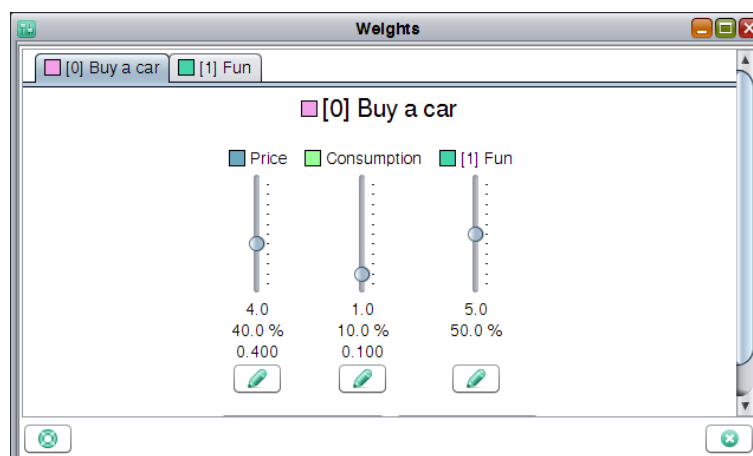
The view displays goal, criteria, alternatives, and groups at the same time. In general, the leaves represent the criteria while inner nodes represent groups. The view allows to zoom in and out using the mouse wheel and to pan by clicking and dragging on the background. Using the second mouse button either on the background or the nodes opens a context menu. The entries of the menu are similar to the ones used in the tree structure of the values window.



Currently zooming out and panning may break the display of the correct context menu. Simply close and reopen the view to reset.

## Weights

The weights window is probably one of the most used interactions with the MCDA. It focusses on defining the importances of criteria. For each criterion respectively group a slider is displayed that allows to easily change the weight of the criterion [Illustration 12].



*Illustration 12: The importance respectively weight editor for criteria and groups.*

Each group is represented by its own panel and can be selected by clicking on the corresponding tab in the upper section of the window. The number in brackets indicates the tier of the group. Within each group each criterion and sub group has its own slider with a value range from 0.0 to

10.0 evaluated relatively to the other members of the group. This means a criterion with weight of 5.0 is considered twice as important as a criterion with weight 2.5. Consequently a value of 0.0 means the criterion is not considered at all. Below the sliders some numbers are displayed. The top value is the absolute local weight in the group, the centre value is the normalised local weight within the group displayed as percentage, and the bottom value is the normalised global weight in respect to all criteria of the MCDA. As an example an absolute normalised weight of 0.4 means that the corresponding criterion has 40% influence on the overall result of the MCDA. Note that groups themselves have no normalised global weight as they do not contribute to the result, but propagate their weight as a multiplier to the weights of their members.

Weights are determined by one of three possible methods: an explicit constant value, a functional value e.g. a probability distribution, or an AHP.

For a constant value, dragging the slider will change the value. Holding Control while doing so will force the value to an integer slot. Using the mouse wheel on a slider will increase respectively decrease the value in steps of 1.

In case the weights are determined by value functions the sliders are locked and the functional weights button allows to replace the current weights by re-evaluating the functions, e.g. to randomly draw values from probabilistically distributed weights.

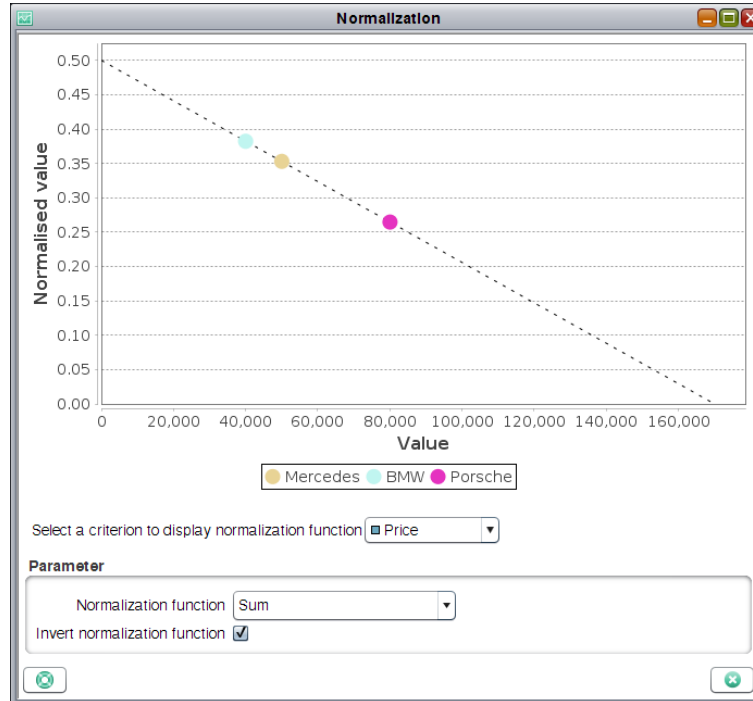
If the weights of the members of a group are determined by AHP the sliders are locked and a button is displayed allowing to discard the AHP and enter weights manually again. Also if no AHP is used a button that allows equalising the weights of all members in the group is available.



Currently the display and handling of functional weights is not intuitive or user friendly. This will be improved in the future.

## Normalisation

The criteria values have to be normalised before combining them. Despite the Sum method being the most general and a large set of additional normalisation methods is integrated and available in the normalisation window [Illustration 13]. You have to select whatever normalisation method seems to fit your criterion best.



*Illustration 13: The editor to manipulate the normalisation of criteria.*

For a selected criterion, the chart displays the mapping of criterion values to the range between 0.0 and 1.0. The graph can be zoomed in by dragging a rectangle to the bottom left corner around an area of interest. Dragging in any other direction will cause to zoom out. The graph also provides a context menu.

The criterion in charge can be selected using the combo box beneath the chart. At the bottom of the view the actual normalisation method can be selected from the according combo box. Some normalisation methods require specific parameters, in which case they are displayed in the lower section of the window.

### **Analytic hierarchy process (AHP)**

The AHP allows to define values or weights of the criteria by systematically and pairwise define the relations of the alternatives for said criterion. For simplification the relations are verbalised and mapped in a predefined range of values [Illustration 14].

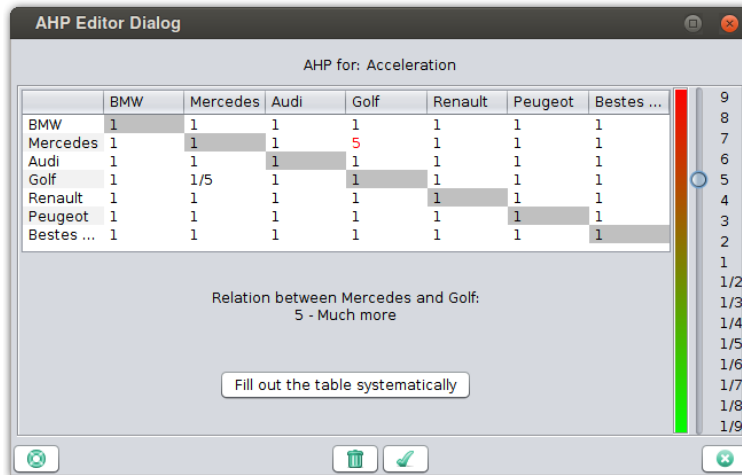



Illustration 14: The AHP view defining the relations of alternatives for a criterion. The result leads to normalised values for this criterion.

 The AHP is quite complex and difficult to handle and therefore it is recommended that it should be used by experienced users only.

### 5.3 Analysing

#### Report

The report tool transforms the mathematical results of the MCDA to a human readable document [Illustration 15].

The generated report contains several sections like e.g. basic information about the MCDA or the result of the stability analysis of the solution. The sections can be enabled or disabled in the options of the tool. Using the export results menu of the main window will generate a HTML file with the same content as the report displays on the screen.

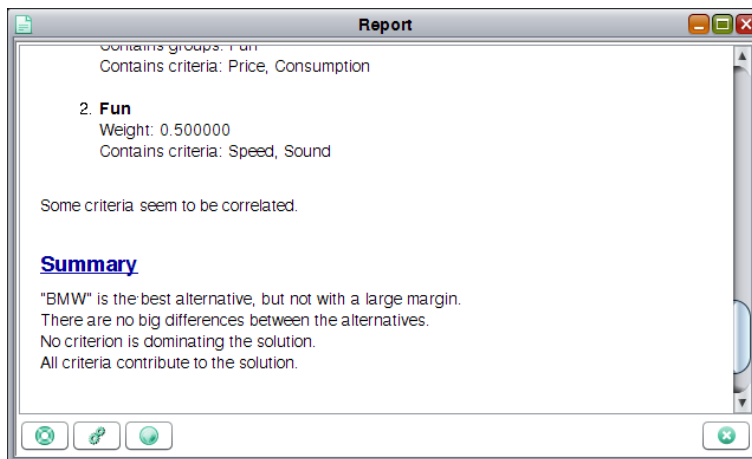


Illustration 15: The report tool verbalising the result

#### Stacked Bar Chart

This window visualises the results of the MCDA as stacked bar chart. For each alternative the resulting value is presented as bar. The parts of the criteria are displayed as stack to indicate their contribution to the bar [Illustration 16].

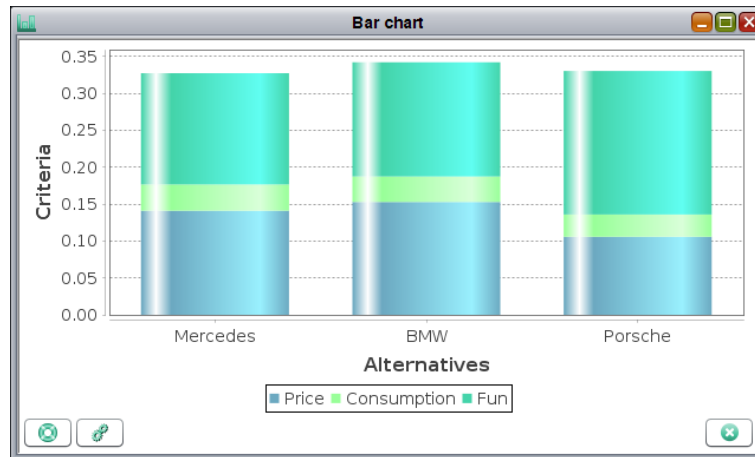


Illustration 16: Visualisation of the MCDA result as stacked bars.

The bars can be sorted to better display the differences between stacks in a distinctive order. To simplify the chart a tier threshold can be defined aggregating groups and criteria above the selected tier into a single contribution.

### Cobweb Chart

Two versions of cob web charts exist: firstly to display the weights of the criteria and secondly to display the results of the MCDA [Illustration 17].

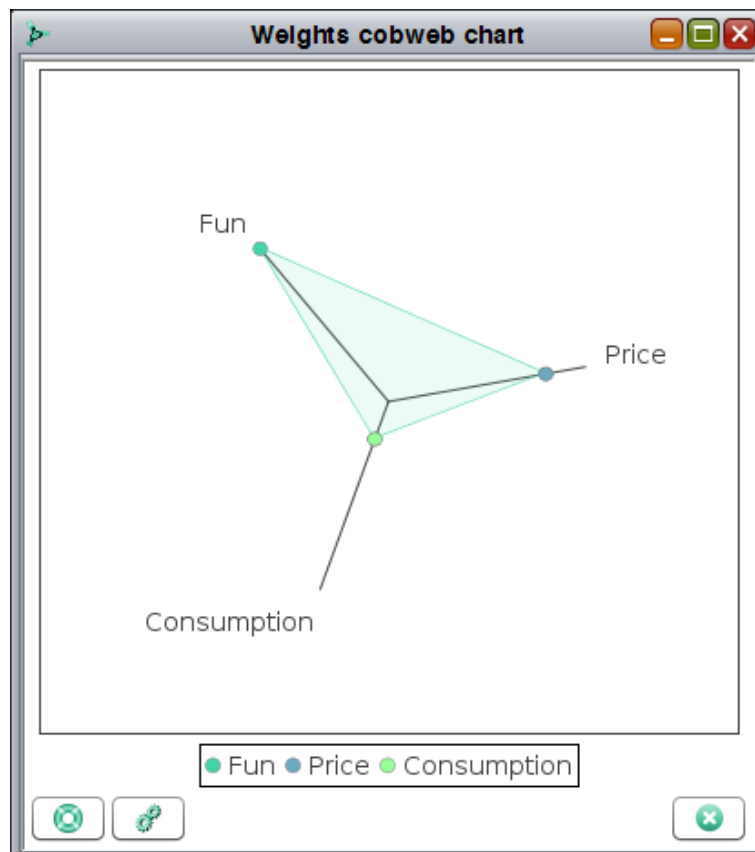


Illustration 17: A cob web chart of the weights of the criteria.

The example shows three criteria where Fun and Price both almost equally contribute to the overall result. The consumption provides only a minor contribution.



## Pie Chart

Pie charts display the portions of contributors in respect to a combined value. Three different pie chart types are implemented in the MCDA: of the result of the MCDA, of the weights and of the values.

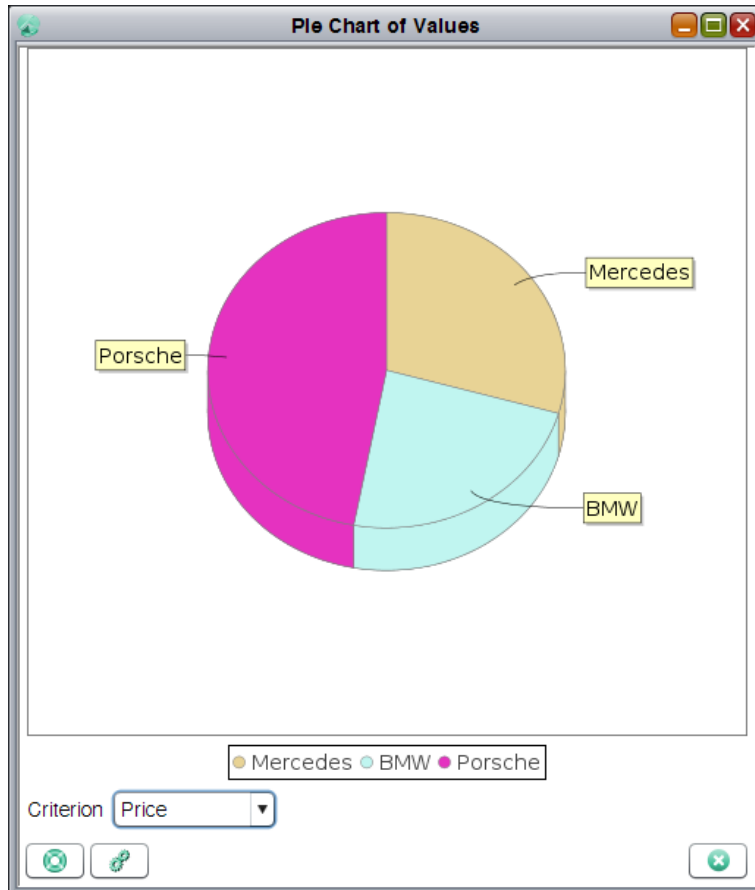


Illustration 18: Pie chart of the values of the criterion price.

If criteria data is displayed the criterion in charge can be selected by a combo box. The options button provides means for selecting custom colours or to sort the sections.

## Multi Tier Pie Chart

The multi tier pie chart displays the absolute weight of criteria as area in a pie chart. Additionally the groups respectively tiers are included in the visualisation [Illustration 19].

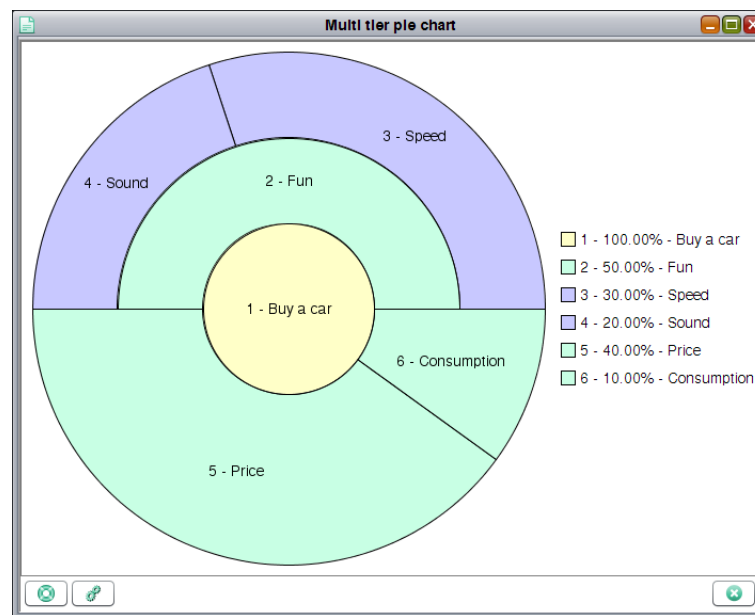


Illustration 19: Weights of criteria displayed as multi tier pie chart.

The criteria and groups are visualised as pie chart. The rings represent the different tiers the groups and criteria are located in. The weights are displayed in percent. As usually in charts zooming and panning with the mouse is possible. Using the options the display of labels, sizes, and colours can be customised.

### Stability of the Analysis

This tool helps understanding about the stability of the results, i.e. what will happen if preferences respectively weights of the criteria are changed [Illustration 20].

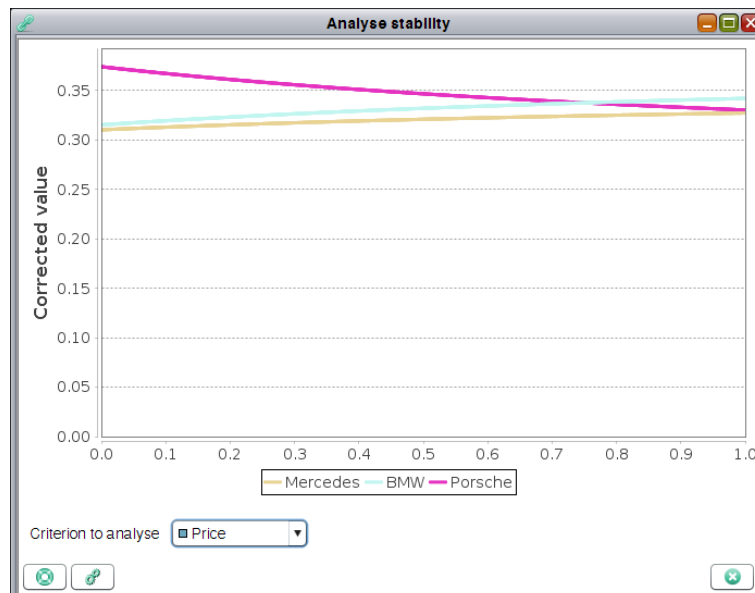


Illustration 20: Analysis of the stability of the MCDA result.

Changing the weight of a criterion influences the result of the MCDA and especially the ranking of the alternatives. The analysis provides two approaches that can be selected from the options: on one hand changing a relative weight of a criterion from 0.0 to 10.0 and on the other hand keep

the relative weight but gradually include the contribution of the criterion in the MCDA from 0.0 to 1.0. The interesting points in the graph are the crossings of the curves indicating a change in the ranking of the alternatives.

### Ranked Correlation of Criteria

This tool provides means to analyse potential correlation of criteria [Illustration 21]. It displays a matrix containing the ranked correlation values. The cells of the matrix are coloured from green over yellow to red indicating low respectively high ranked correlation.



The screenshot shows a window titled "Ranked correlation" with a table of correlation values between four criteria: Price, Speed, Consumption, and Sound. The diagonal elements are all 1.000. The off-diagonal elements are 0.500, indicating a moderate correlation between Price and Speed, Price and Consumption, and Speed and Consumption. The correlation between Price and Sound is 1.000 (red), and between Speed and Sound is 0.500 (yellow).

	Price	Speed	Consumption	Sound
Price	1.000	0.500	0.500	1.000
Speed	0.500	1.000	1.000	0.500
Consumption	0.500	1.000	1.000	0.500
Sound	1.000	0.500	0.500	1.000

*Illustration 21: Analysis of ranked correlation between criteria.*



The ranked correlation is just one method of many to determine potential correlation and an intelligent interpretation is required.

## **Appendix A: Menu and Tool bar referenced**

- Analysis→Charts→Cobweb charts→Values  
Cobweb Chart, page 27
- Analysis→Charts→Cobweb charts→Weights  
Cobweb Chart, page 27
- Analysis→Charts→Stacked bar chart  
Stacked Bar Chart, page 26
- Analysis→Charts→Pie charts→Results  
Pie Chart, page 28
- Analysis→Charts→Pie charts→Values  
Pie Chart, page 28
- Analysis→Charts→Pie charts→Weights  
Pie Chart, page 28
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Multi Tier Pie Chart, page 28
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Graphs, page 22
- Edit→Meta data  
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Normalisation, page 24
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Weights, page 23
- Analysis→Ranked correlation  
Ranked Correlation of Criteria, page 30
- Analysis→Stability  
Stability of the Analysis, page 29
- Analysis→Report  
Report, page 26

## **Appendix B: Localization**

Creating translations for languages other than English or German is trivial. In general it is sufficient to fill a text file with the according translations. However at the moment no automatic mechanism is established to include local translations. If you are interested in having a specific localisation (Spanish, French, ?, ...) do not hesitate to contact us. If (quite) complete it can easily be integrated into the MCDA application.

It is also possible to just have the report localized and keep the user interface in default english language. Several auto-generated translations (Slovak, Spanish, Italian, ...) for the report have been included as example.

## **Appendix C: Customization**

The base directory containing icons, images and colour definitions is customization within the MCDA distribution folder.

Simply edit the files or replace them to customise the application to your needs.

Still more details need to be described here in later editions.



It is recommended to create backups before making any changes. The MCDA tool may not start if the file contents are broken.

## **Appendix D: File Format**

For persistent data storage the XML file format is used. Most of the tags are self explaining. Nevertheless a detailed description of the file format with the XML Schemes and examples are available in the directory docs/XML of the MCDA distribution folder.

## **Appendix E: Tips and Tricks**

- Hover the mouse over buttons, texts, charts, etc. Very often a help text will pop up explaining the context.
- Change values in the value window (Edit→Values) by hovering over the according cell and click of the second mouse button respectively the right one. Change nominal values by double click and selecting a value from the list.
- Change values in the weights window (Edit→Weights) by dragging the slider in the according direction or by scrolling the mouse wheel. Holding down the CTRL-Key will snap to integer values.
- Change the normalisation in the normalisation window (Edit→Normalisation). Most of the time “Linear auto” respectively Min-Max method is sufficient. You can also access the normalisation window by right click on criterion in the values window.



## **Bibliography**

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