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DEXiWin: DEX Decision Modeling Software

**User's Manual
Version 1.2**



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DEXIWIN SOFTWARE



DEXiWin

Version 1.2

DEX Decision Modeling Software

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Department of Knowledge Technologies, Jožef Stefan Institute

<https://dex.ijs.si/>

Uses DEXi Library V1.02

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DEXiWin is a desktop program for Microsoft Windows aimed at developing and using hierarchical qualitative multi-criteria decision models according to the *method DEX*. The program is useful for supporting complex decision-making tasks.

1.1 Functionality

DEXiWin supports the following tasks:

1. Developing *DEX models*: creating and editing *DEX models* and their components:
 - Attributes: variables that represent decision subproblems and properties, observed at decision alternatives.
 - Tree of attributes: a hierarchical structure representing the decomposition of the decision problem.
 - Scales: discrete and continuous scales that define admissible values that can be assigned to attributes.
 - Aggregation and discretization functions: functions that define the aggregation/discretization of attributes from the bottom to top of the attribute tree.
2. Evaluation and analysis of decision alternatives:
 - Creation and editing of alternatives and their values, assigned to individual attributes.
 - Evaluation of alternatives: a bottom up aggregation of alternatives' values in accordance with model structure and defined functions.
 - Analysis of alternatives: what-if analysis, selective explanation, comparison of alternatives, "plus-minus" analysis, target analysis.
3. Other graphical-user-interface and input-output features:

- Loading and saving DEX models in the native XML format (.dxi files).
- Copying, pasting, importing and exporting DEX models and their parts in various formats: Json, tab-delimited and CSV (Comma-Separated Value).
- Reporting: creating, combining, displaying and exporting various reports.
- Charts: creating and displaying various customizable charts.
- Tree graphic view: graphic display of model structure.

1.2 Compatibility

DEXiWin is backward compatible with [DEXi](#). It implements all DEXi's features, except loading and saving DEXi models in obsolete data formats (.dax and pre-2000 .xml). DEXiWin can read and process .dxi files produced by DEXi. Also, unless new DEXiWin features are used, .dxi files remain readable by DEXi.

In comparison with DEXi, DEXiWin introduces several new features:

- DEXiWin supports all DEX method extensions introduced in [DEXi Suite](#).
- Additional features for handling decision rules: considering symmetry, marginal values, representation using decision trees, graphical interpretation using linear functions, multilinear interpolation and QQ evaluation.
- “Plus-minus-1” analysis is generalized to “Plus-Minus-AnyValue” analysis.
- Added Qualitative-Quantitative (QQ) evaluation for ranking alternatives within qualitative classes.
- Added new report types, supporting a flexible composition of reports.
- Added new chart types. Some of the old ones have been redesigned and extended, too.
- Implemented many small, but important improvements in the user interface, for instance displaying model components in user-selectable columns, tree-structured display/editing of evaluation results, consistent use of colors for displaying ‘good’ and ‘bad’ value categories, predefined scales, etc.
- Incorporated the functionality of [DEXiTree](#).
- Most user-defined settings are now remembered in .dxi files.

1.3 Motivation and History

DEXiWin has been developed with the motivation to eventually replace [DEXi](#), a Windows program for multi-attribute decision making. DEXi has been conceived in 1999 as educational software. Since 2000, additional features were gradually added to DEXi, which eventually became a complete, stable, and *de facto* standard implementation of [method DEX](#). After 20 years, DEXi has reached a point where further maintenance and improvements are difficult. DEXi is built on an otherwise excellent, but largely outdated technology (Delphi) and has some design flaws that complicate the addition of new features. In particular, the user interface and model operations are insufficiently detached from each other. Additionally, user-interface components that were available in 2000 do not fulfill today's requirements any more. This situation demanded a thorough renovation of the software.

DEXiWin has been redesigned and rebuilt from the scratch. It is now composed of two parts, a platform-independent software library [DEXiLibrary](#) for handling DEXi models, and DEXiWin itself, which implements a Windows-platform GUI over [DEXiLibrary](#). The GUI is based on [Microsoft WinForms](#), a mature platform to write desktop applications for personal computers. WinForms, together with an excellent [ObjectListView](#) open-source control by Phillip Piper, allowed us to design a consistent user interface that, at a first glance, looks very similar to DEXi's, but improves on many aspects that were not achievable in DEXi: consistent use of colors in displaying good and bad values, structuring evaluation results, and many more. Reports and charts were thoroughly redesigned, too.

1.4 License

DEXiWin: DEXi Decision Modeling Software

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You should have received a copy of the GNU General Public License along with this program. If not, see <https://www.gnu.org/licenses/gpl-3.0.en.html>.

DEXiWin uses third-party open-source software. Please see documentation distributed with the software for the list and respective licenses.

1.5 Availability

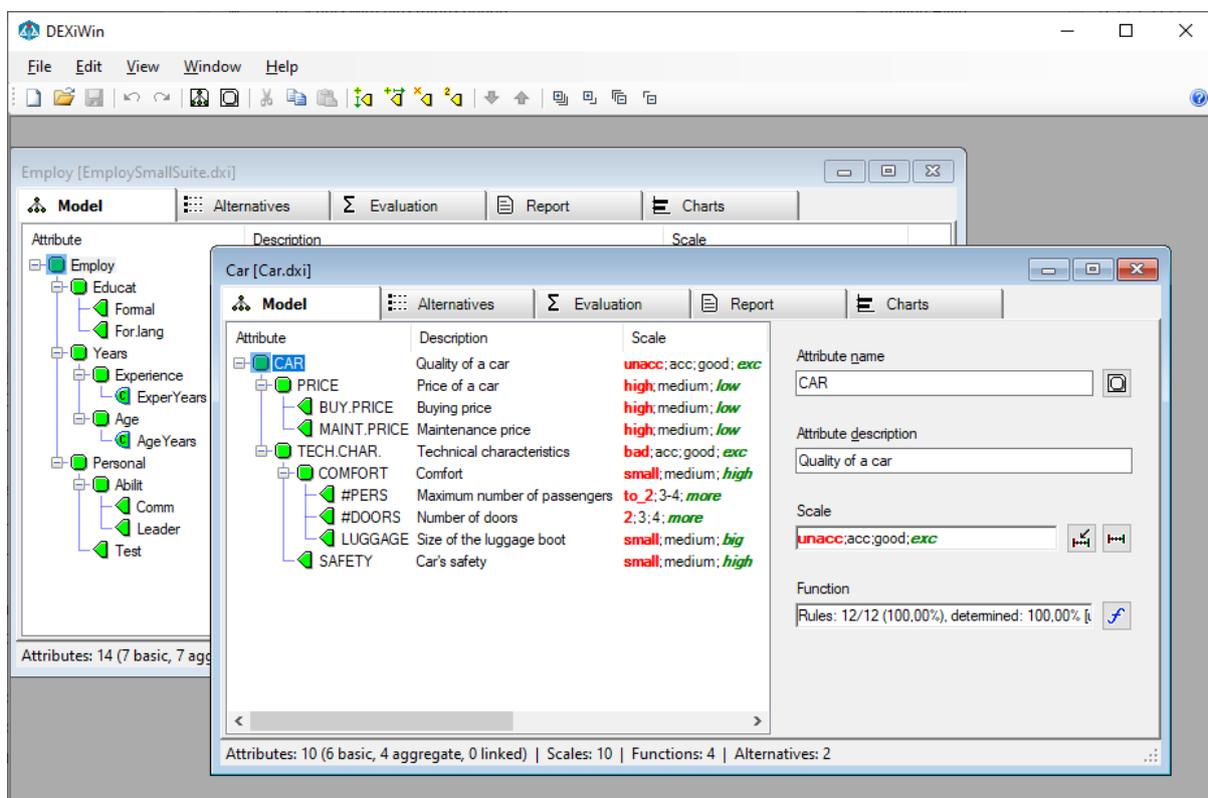
The latest version of DEXiWin can be downloaded from:

<https://dex.ijs.si/dexisuite/dexiwin.html>

DEXiWin is distributed as freeware under the GNU General Public License. All distributed versions of DEXiWin are fully functional. The software is provided “as-is”, without any express or implied warranty.

DEXIWIN USER INTERFACE: MAIN ELEMENTS AND MENUS

At the top level, DEXiWin provides a standard Windows MDI (Multi-Document User Interface), where a “document” is a *DEXi Model*. You can work with one or more models at the same time. Each model is displayed in a single *Model Window*.

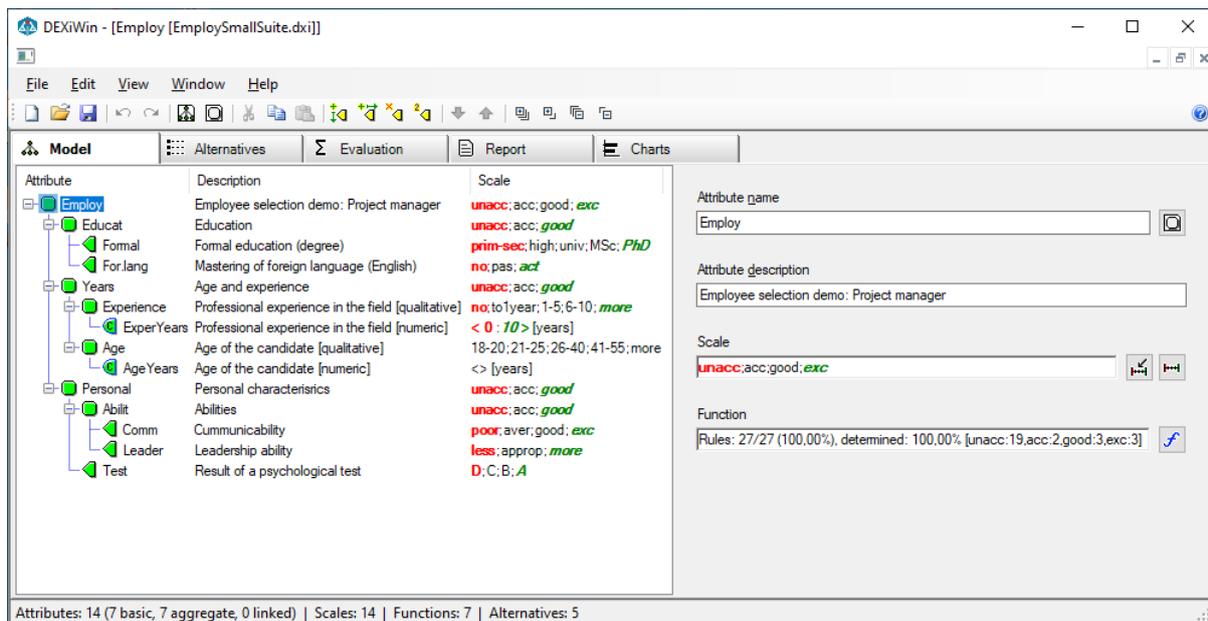


Commands, available through menus and toolbars, generally change according to the contents shown in the DEXiWin’s main window and focused *Model Window*. In general, the following menus and corresponding toolbar counterparts are available:

- *File*
- *Edit*
- *View*
- *Analysis*
- *Window*
- *Help*

The main menu for arranging *Model Windows* in the DEXiWin’s workspace is *Window*.

2.1 Model Window



A DEXiWin *Model Window* provides workspace for editing and using one *DEXi model*. It consists of several pages ('tabs'). The first five are fixed and available at all times:

 *Model*: Edit the structure and components of a DEXi Model

 *Alternatives*: Edit alternatives and their input data

 *Evaluation*: Evaluate and analyse alternatives

 *Report*: Compose and view the main report

 *Charts*: Compose and view charts

Additional *Report* and *Tree View* pages may be created while using DEXiWin. They are temporary and can be closed/discarded.

2.2 DEXi Model

The term *DEXi Model* refers to the "document" that is created and edited in a DEXiWin's *Model Window* and stored externally on a *DEXi File*.

A DEXi model contains data about:

- a multi-criteria DEX model,
- considered decision alternatives.
- user's *settings*.

2.3 DEXi File

Each *DEXi model*, which is created and/or edited DEXiWin, can be stored on a *DEXi File*. This is a XML-formatted text file whose default extension is `.dxi`.

Generally, a *DEXi File* contains the following data:

- a multi-criteria DEX model,
- data about considered decision alternatives, and
- user's *settings*.

DEXiWin can read *DEXi Files* created by its predecessor DEXi. The converse is possible, but generally not true.

2.4 File Menu

The DEXiWin *File Menu* is available at all times for working with the currently active *DEXi model window*. It mainly provides commands for creating, loading and saving *DEXi files*, but there are also commands for importing and exporting other data, changing user's settings and exiting DEXiWin.

 **New:** Create a new *DEXi model* and open a corresponding *window*. Initially, the model is almost empty, containing only one root attribute and no alternatives.

 **Open:** Open and load an existing *DEXi file* through a standard open file dialogue.

Close: Close the currently active *DEXi model window*. Before closing, DEXiWin checks whether the model has been saved on a *DEXi file*, and if not, asks whether to: save the model (**Yes**), discard the model (**No**), or to **Cancel** closing the window.

 **Save:** Save the currently edited model on a *DEXi file*. This is a “quick” save that normally rewrites the output file without confirmation. However, it does ask you to provide a file name for a newly created and yet unsaved model.

Save as...: Save the currently edited model on a *DEXi file*. In this case, a **Save file** dialogue appears before saving and always lets you define or redefine the name of the file.

Import.../Import function: Open a *function file* and load its definition into the function associated with the currently selected attribute. The function is created if necessary. Imported are only those rules of aggregation functions whose argument values in the file are matched with the ones in DEXiWin. Even though DEXiWin tries to recognize the data format used in the function file, it is strongly recommended that function data is exported and imported using the same *Import/Export settings*.

Import.../Import alternatives: Open an *alternatives* or *Json <FileJson>* file and load its data into the current *model*. Existing alternatives that have the same names as imported alternatives are overwritten by imported data. Otherwise, imported alternatives are inserted in the model. Before importing, you are asked to specify the name and format of the file.

Export.../Export model: Export the current *DEXi model* to an external *Json* data file.

Export.../Export tree: Export the current tree of attributes to an external file. Two data formats are supported:

- GML (Graph Modelling Language): for creating tree graphs by programs such as yEd Graph Editor.
- Tab-delimited: textual format with columns containing attribute names, scales and descriptions;

Export.../Export function: Save the function that is associated with the currently selected attribute. Data is written to a *function file*. Before exporting, you are asked to define file name. Only “Tab-delimited” format is available.

Export.../Export alternatives: Extract alternatives' data from the current model and save it on an *alternatives* or *Json* <*FileJson*> file. Before exporting, you are asked to specify the name and format ("Tab-delimited", "CSV" or "Json") of the file.

When exporting alternatives from any of the *Alternatives* or *Evaluation* Pages, only alternatives visible on that page are exported. Otherwise, all alternatives are exported.

Settings...: View and edit user's *settings*.

Exit: Close all windows and terminate the execution of DEXiWin.

2.4.1 Function Data File

Function data files are tab-delimited text files for storing aggregation and discretization functions, which are exported and imported through *File Menu* commands: **File/Export function...** and **File/Import function...**, respectively. One file contains one function, whose format can be specified with *Import/Export settings*.

Examples

1. *TECH.CHAR.* function from the *Car Evaluation* model, exported in tab-delimited format, using 'Base 1' values and exporting all rules. The character + represents an entered rule. Here, the TAB character is denoted \rightarrow .

```
 $\rightarrow$ COMFORT $\rightarrow$ SAFETY $\rightarrow$ TECH.CHAR.  
1 $\rightarrow$ 1 $\rightarrow$ 1 $\rightarrow$ 1 $\rightarrow$ +  
2 $\rightarrow$ 2 $\rightarrow$ 1 $\rightarrow$ 1 $\rightarrow$ +  
3 $\rightarrow$ 3 $\rightarrow$ 1 $\rightarrow$ 1 $\rightarrow$ +  
4 $\rightarrow$ 1 $\rightarrow$ 1 $\rightarrow$ 1 $\rightarrow$ +  
5 $\rightarrow$ 2 $\rightarrow$ 2 $\rightarrow$ 2 $\rightarrow$ +  
6 $\rightarrow$ 3 $\rightarrow$ 3 $\rightarrow$ 3 $\rightarrow$ +  
7 $\rightarrow$ 1 $\rightarrow$ 1 $\rightarrow$ 1 $\rightarrow$ +  
8 $\rightarrow$ 2 $\rightarrow$ 3 $\rightarrow$ 3 $\rightarrow$ +  
9 $\rightarrow$ 3 $\rightarrow$ 4 $\rightarrow$ 4 $\rightarrow$ +  

```

2. The same function exported using text values and exporting only entered rules (in this case there is no need to display the + or - entered status).

```
 $\rightarrow$ COMFORT $\rightarrow$ SAFETY $\rightarrow$ TECH.CHAR.  
1 $\rightarrow$ bad $\rightarrow$ bad $\rightarrow$ bad  
2 $\rightarrow$ acc $\rightarrow$ bad $\rightarrow$ bad  
3 $\rightarrow$ good $\rightarrow$ bad $\rightarrow$ bad  
4 $\rightarrow$ bad $\rightarrow$ bad $\rightarrow$ bad  
5 $\rightarrow$ acc $\rightarrow$ acc $\rightarrow$ acc  
6 $\rightarrow$ good $\rightarrow$ good $\rightarrow$ good  
7 $\rightarrow$ bad $\rightarrow$ bad $\rightarrow$ bad  
8 $\rightarrow$ acc $\rightarrow$ good $\rightarrow$ good  
9 $\rightarrow$ good $\rightarrow$ exc $\rightarrow$ exc  

```

3. *Experience* discretization function from the *Employee Selection* model, using 'Base 1' values.

```

-ExperYears--Experience
1--1-+
-0-]-
2--2-+
-1-]-
3--3-+
-5-]-
4--4-+
-10-[
5--5-+

```

Observe the alternating lines: lines beginning with 1 to 5 define output values of the corresponding input value intervals, while the intermediate lines define interval boundaries. The characters] and [determine which interval, previous or next, contains the corresponding bound. In this case, there are 5 intervals:

- $[-\infty, 0]$ -> value 1 (“no”)
- $(0, 1]$ -> value 2 (“to1year”)
- $(1, 5]$ -> value 3 (“1-5”)
- $(5, 10)$ -> value 4 (“6-10”)
- $[10, +\infty]$ -> value 5 (“more”)

2.4.2 Alternatives Data File

Alternatives data files contain data about alternatives, which is exported and imported through *File Menu* commands: `File/Export alternatives...` and `File/Import alternatives...`, respectively. In DEXiWin, the contents and format of alternatives’ files are controlled at the following points:

- In ‘Import alternatives’ and ‘Export alternatives’ dialogues that are used to specify file names and basic file format, which is either ‘Tab-delimited’ or ‘Comma-separated (CSV)’.
- In *Settings/Import-Export*, where you can specify further details under “Alternatives data format”.

Examples

1. Tab-delimited alternatives data file containing both alternatives from the *Car Evaluation* model, exported using the default Import/Export settings: : using ‘Base 1’ values, displaying all attributes using indentation, normal orientation, invariant (international) CSV format. Here, the TAB character is denoted `↵`.

```

-Car1-Car2
CAR↵4↵3
. PRICE↵3↵2
. . BUY.PRICE↵2↵2
. . MAINT.PRICE↵3↵2
. TECH.CHAR.↵4↵3
. . COMFORT↵3↵3
. . . #PERS↵3↵3
. . . #DOORS↵3↵3
. . . LUGGAGE↵3↵3
. . SAFETY↵3↵2

```

2. The same data as above but using the comma-separated format, 'Base 0' values and including only non-indented basic attributes in normal orientation.

```
"", "Car1", "Car2"  
"BUY.PRICE", "1", "1"  
"MAINT.PRICE", "2", "1"  
"#PERS", "2", "2"  
"#DOORS", "2", "2"  
"LUGGAGE", "2", "2"  
"SAFETY", "2", "1"
```

3. The same as above, but with text values and transposed orientation.

```
"", "BUY.PRICE", "MAINT.PRICE", "#PERS", "#DOORS", "LUGGAGE", "SAFETY"  
"Car1", "medium", "low", "more", "4", "big", "high"  
"Car2", "medium", "medium", "more", "4", "big", "medium"
```

2.4.3 Json Data File

Json ([JavaScript Object Notation](#)) is an open standard file and data interchange format that uses human-readable text to store and transmit data objects. *Json Data Files* have been introduced in DEXiWin to provide a rich and flexible way of storing all components of a *DEXi model*, including model components and data about alternatives, in a form that can be easily reviewed and interchanged with other software, web services, etc. Also, the format addresses the issue of having multiple equally-named attributes in a single model, which caused difficulties while using other data formats.

Json Data Files are exported and imported through *File Menu* commands: `File/Export model...`, `File/Export alternatives...`, `File/Import model...` and `File/Import alternatives...`, after choosing the *Json* format in the corresponding save file dialogues.

The exact contents of exported files depend on *File/Settings/Json*, where it is possible to define many formatting options, including the selection of individual elements to be included in the file.

When importing a Json data file, DEXiWin tries to recognize the specific format settings that had been used while writing the file. Nevertheless, it is recommended to export and import Json data using the same settings.

Recommendation

Given so many options for altering the *Json Data File* format, we suggest to experiment by changing *File/Settings/Json* and observing the effects on the exported data file(s).

Example

Example shows the [Car Evaluation](#) model, exported by `File/Export model...`, using the following Json settings: *Flat* file structure, using *Text* values, including both model components and alternatives' data, and including the default data items. Only an excerpt from the exported file is shown below for illustration.

```
{  
  "name": "Car",  
  "structureFormat": "flat",  
  "valueFormat": "text",
```

(continues on next page)

(continued from previous page)

```

"valueStrings": true,
"distrFormat": "dict",
"model": [
  {
    "name": "CAR",
    "description": "Quality of a car",
    "path": "/CAR",
    "id": "CAR",
    "type": "aggregate",
    "scale": {
      "order": "ascending",
      "interval": true,
      "type": "discrete",
      "values": [
        {
          "name": "unacc",
          "description": "unacceptable car",
          "group": "bad"
        }
      ],
    },
  },

```

Other CAR scale values omitted ... Follows the definition of CAR's aggregation function:

```

"function": {
  "table": {
    "dimension": "3;4",
    "rules": [
      {
        "args": "0;0",
        "value": "0",
        "entered": true
      }
    ],
  },

```

Other CAR function rules omitted ... Follows the list of CAR's descendant attributes:

```

},
"inputs": [
  {
    "name": "PRICE",
    "description": "Price of a car",
    "path": "/CAR/PRICE",
    "id": "PRICE",
    "type": "aggregate",
    "scale": {

```

Further attribute data omitted ... Follows the list of alternatives and associated data:

```

"alternatives": [
  {
    "name": "Car1",
    "values": [
      {
        "name": "CAR",
        "path": "/CAR",
        "id": "CAR",
        "string": "3",
        "value": "exc"
      }
    ],
  },

```

(continues on next page)

(continued from previous page)

```
{
  "name": "PRICE",
  "path": "/CAR/PRICE",
  "id": "PRICE",
  "string": "2",
  "value": "low"
},
```

Further alternatives' data omitted...

2.5 Edit Menu

DEXiWin's *Edit menu* adapts to the contents of the currently selected page in the *Model Window*. The page-specific *Edit* menus are:

- *Model Page*
- *Alternatives Page*
- *Evaluation Page*
- *Report Page* while showing a report using
 - *document* format
 - *HTML* format
- *Charts Page*
- *Tree View*

2.6 View Menu

DEXiWin's *View menu* changes with respect to the currently selected page in the *Model Window*. The page-specific *View* menus are:

- *Model Page*
- *Alternatives Page*
- *Evaluation Page*
- *Report Page*
- *Tree View*

2.7 Window Menu

Window Menu is available at all times and provides commands for working with *DEXi Model Windows*. These commands are particularly useful when there are multiple models loaded simultaneously and shown in the *main window* of DEXiWin.

Cascade: Stack currently open windows so that each window's title bar is visible. This prepares for an easy selection of windows.

Tile horizontally: Resize and move all currently open windows so that they are shown above each other, occupying the full width of the main window.

Tile vertically: Resize and move all currently open windows so that they are shown behind each other, occupying the full height of the main window.

Arrange icons: Neatly arrange icons that indicate minimized model windows. Maximized and normal-size windows are not affected by this command.

Resize forms: Change the appearance of all model windows, either **Minimize** or **Maximize** them, or show them in the workspace using their previous **Normal size** settings.

Font size with subcommands **Reset**, **Enlarge** and **Shrink**: Accordingly change the size of the text displayed on the screen. Enlarging font size, for instance, is convenient for presentations, team work and for users with bad eyesight. Only the most important model-related screen elements are affected by these commands.

2.8 Help Menu

Help Menu commands provide help on DEXiWin.



Help: Show this help.

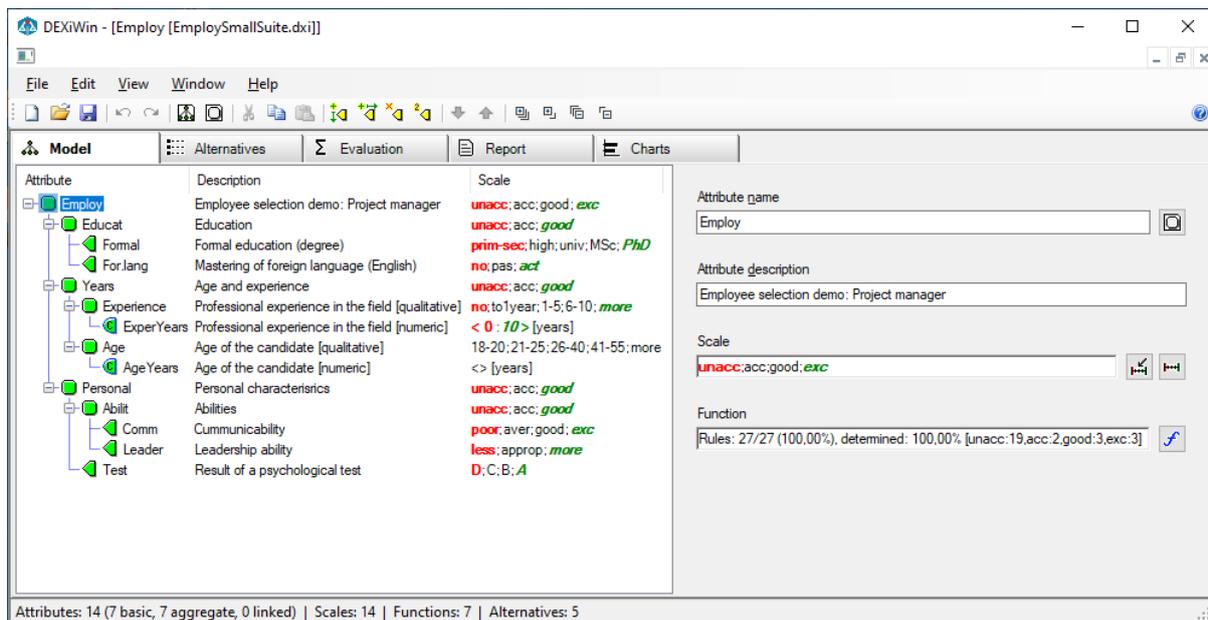


About...: Show DEXiWin version and copyright information.

For further information and latest news, see the [DEXiWin Web Page](#).

MODEL PAGE

The *Model Page* of DEXiWin *Model Window* provides *workspace* and *commands* for editing a *DEXi model*: its structure, attributes, scales and functions, but excluding alternatives.



Workspace

The *Model Page* workspace consists of two main areas:

- *Model tree view* (left): This area displays the structure of the edited model. The first column shows attributes and their *status*. There are up to three associated columns that display the selected attribute's *Description*, *Scale* and *Function* summary. The visibility of individual columns can be selected through the *View* menu.
- *Attribute panel* (right): Contains fields for editing the name, description, scale and function of the currently selected attribute in the *Model tree view*. This panel can be visible or not, depending on *View* menu settings.

There are four buttons located on the panel, which correspond to *commands* that activate editing windows:

- Attribute's name and description
- *Scale Editor*, associated with
 - * *Scale Selection*
- *Function Editor* (available only for aggregate attributes)

Commands

Model Page commands can be invoked by:

- Pressing a button shown on the toolbar or *Attribute panel*
- Invoking some *editing command*
- Selecting an item from the pop-up menu that appears after right-clicking the mouse
- Selecting an item from the menus:
 - *File*
 - *Edit*
 - *View*
 - *Window*
 - *Help*

Model Editing Commands

 **Edit model name and description:** Opens a separate window for editing this model's name and description.

 **Edit attribute name and description:** Opens a separate window for editing the name and description of the currently selected attribute.

 **Add attribute:** This command creates a new attribute and inserts it into the tree as a sibling of the currently selected attribute. The new attribute is automatically called “New”, so you should consider giving it a more meaningful name.

 **Add child:** Creates a new attribute and inserts it into the tree as a child of the currently selected attribute. The new attribute is automatically called “New”, so you should consider giving it a more meaningful name.

 **Delete attribute or subtree:** The effect of this command depends on the type of the currently selected attribute:

- For an aggregate attribute: it discards all its descendants and its function, effectively converting it into a basic attribute.
- For a basic attribute: it deletes that attribute.

Thus, to completely delete a sub-tree of attributes from the model, you should “delete it twice”.

 **Cut:** Equivalent to **Copy** followed by **Delete attribute or subtree**.

 **Copy:** Copies the currently selected sub-tree into the clipboard for further use.

 **Paste:** Inserts previously **Cut** or **Copied** sub-tree into the model, replacing the currently selected basic attribute. Pasting is enabled only when positioned on a basic attribute that has a compatible scale with the cut/copied subtree.

 **Duplicate:** Makes a copy of the currently selected attribute or sub-tree and inserts it as a new top-level sub-tree in the model, so that it can be moved around later.

 **Move down:** Moves the currently selected attribute one place down according to what is shown in the tree view.

 **Move up:** Moves the currently selected attribute one place up according to what is shown in the tree view.

 **Search...**: Open a window in which you can define a text to be searched for in the model. You can also select components in which to search: attribute names, attribute descriptions, and/or scales. The search can be case sensitive or not.

 **Find next**: Continues searching from the current position in the model.

 **Undo**: Undo the last tree-editing operation.

 **Redo**: Redo the last undone tree-editing operation.

Edit/Scale

 **Edit scale...**: Invokes the *Scale Editor* to create or edit the scale of the currently selected attribute.

 **Select scale...**: Invokes the *Scale Selector* window to select/change the scale of the current attribute from the list of compatible scales.

 **Delete scale**: Deletes the scale of the currently selected attribute.

 **Reverse scale**: The scale of the currently selected attribute is reversed: all scale's values are put in reverse order, and the scale's order is changed from ascending to descending or vice versa. The underlying functions, if any, are also changed so that the original function mappings are preserved.

Edit/Function

 **Edit function**: Invokes the *Function Editor* to create or edit the aggregation or discretization function corresponding to the currently selected aggregate attribute.

 **Delete function**: Deletes the aggregation or discretization function associated with the currently selected aggregate attribute.

Other Model Editing Commands

The following model editing commands can also be invoked on the *Model tree view*:

F2 or double click on attribute name: Start editing attribute name.

Double click on attribute name or description: Start editing the text.

Drag and drop: Move individual attributes or sub-trees from one position in the model to another. After dropping, the moved subtree is attached as a child to the target attribute. Only those moves are allowed that do not introduce cycles in the model. A subtree cannot be moved to itself.

Join attributes: This is a special case of **Drag and drop** for joining (merging) two attributes together. It can be invoked by dragging a child attribute to the parent one, but only when the former is the only child of its parent and the scales of the attributes are compatible.

View Menu

-  **Expand all:** Fully expand tree view and show all attributes.
 -  **Expand one level:** Extends the display of the tree by expanding the inner-most collapsed sub-trees by one level.
 -  **Collapse all:** Fully collapse tree view so that only root attributes are displayed.
 -  **Collapse one level:** Collapses the display of the tree by one level.
- F8 Resize columns:** Adapt columns of the *Model tree view* to the actual width of displayed text.
- Attribute panel:** Display or hide *Attribute panel*.
- Description:** Display or hide the *Description* column in the *Model tree view*.
- Scale:** Display or hide the *Scale* column in the *Model tree view*.
- Function:** Display or hide the *Function* summary column in the *Model tree view*.
-  **Tree view...:** Open the *Tree View* window.

Attribute Status

In the *Model tree view*, attributes are associated with different icons that indicate their status.

Status of Aggregate Attributes

- : Aggregate attribute without defined scale and function.
- : Aggregate attribute with defined scale, but undefined function. A function cannot be created due to incompletely defined child attributes.
- : Aggregate attribute with defined scale, but undefined function. A function can be created.
- : Aggregate attribute with defined scale and function. However, the function is not fully determined.
- : Aggregate attribute with defined scale and fully determined function (the desired state of any function).

Status of Basic Attributes

- : A basic attribute with an undefined scale.
- : A basic attribute with a defined *discrete* (qualitative) scale.
- : A basic attribute with a defined *continuous* scale.
- : A *linked* attribute.

Remarks

Changing the structure and scales of attributes can substantially affect previously defined functions and alternatives. In some cases, for example when adding or deleting an attribute value, DEXiWin tries to adapt the affected function and alternatives so that information is preserved as much as possible. Unfortunately, such adaptation are not possible with some drastic changes, such as when adding or deleting attributes. In these cases, the function is deleted by DEXiWin and should be defined anew. Before deleting a function, DEXiWin issues a warning and asks for confirmation.

Consequently, you might want to develop your tree structure as completely as possible before attempting to define functions and alternatives.

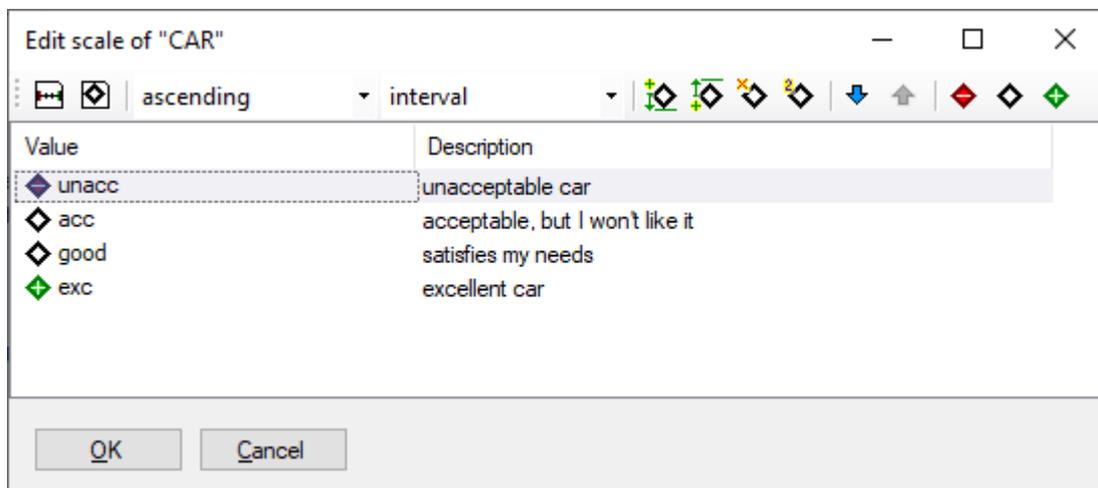
3.1 Scale Editor

Scale Editor is generally a window in which you can create and edit one attribute's *scale*. Since the method DEX uses two types of scales, *qualitative* and *continuous*, DEXiWin provides two corresponding editors:

- *Qualitative Scale Editor*
- *Continuous Scale Editor*

3.2 Qualitative Scale Editor

A *qualitative scale* can be associated with any attribute. Basically, a qualitative scale is just a list of values, which may, but need not, be preferentially ordered. You can add and delete these values, give them names and optional descriptions, change their order and categorize them as 'bad', 'neutral' or 'good'.



Workspace

Qualitative Scale Editor consists primarily of a *Value table*. Each scale value has a name (usually a short string) and an optional description (used only for documentation).

Editing commands can be issued through buttons and selection lists in the editor's toolbar, and by selecting items from the menu that appears after clicking the right mouse button.

Commands

F2, pressed while positioned on some selected value name or description, starts editing of the underlying text.

 **Edit scale value and description:** Open a separate window for editing this scale's name and description.

 **Edit value name and description:** Open a separate window for editing the name and description of the currently selected scale value.

Scale order: a list for defining the scale's *preferential order*, which can be: **ascending**, **descending** or **unordered**.

Scale type: a list to define how to display **DEX values** on this scale:

- **interval:** it is allowed to use *intervals*, such as $\leq \text{acc}$, or
- **categorical**, i.e., always display values without intervals, for instance **bad**; **acc**.

 **Add value down:** Inserts a new value right after the currently selected value. The default name of this value is "new", and you may want to rename it by pressing **F2**.

 **Add value up:** Inserts a new value right before the currently selected value.

 **Delete value:** Deletes the currently selected value.

 **Duplicate value:** Duplicates the currently selected value and inserts it right after the currently selected value.

 **Move down:** Moves the currently selected value one place down along the value list.

 **Move up:** Moves the currently selected value one place up in the value list.

 **Set bad category:** Set the category of the currently selected value to 'bad'.

 **Set neutral category:** Set the category of the currently selected value to 'neutral' (nor 'bad' nor 'good').

 **Set good category:** Set the category of the currently selected value to 'good'.

Remarks

Editing a scale (especially adding and deleting values) may affect already defined functions. DEXiWin tries to adapt the affected functions so that their 'meaning' is preserved as much as possible, but you should be careful and verify all affected functions after making such changes.

Ascending scales are strongly recommended: they improve the comprehensibility of models and simplify the editing of *aggregation functions*.

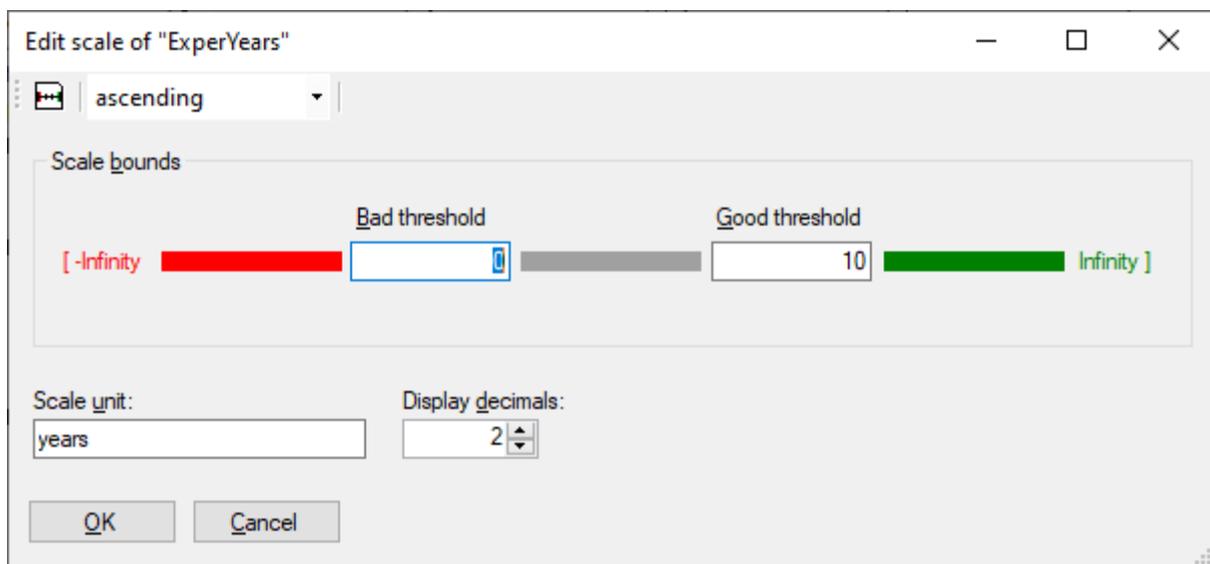
Displaying ascendingly ordered DEX values with *intervals* is usually more compact and comprehensible than as *categorical*, and is thus recommended. However, the categorical setting may be better suited for unordered scales and whenever intervals appear inappropriate or confusing, which largely depends on scale definition.

The concept of value *category* ('bad', 'neutral', 'good') is meaningful only with ordered scales. Thus, the commands ,  and  do not work with **unordered** scales. For **ordered** scales, categories must be ordered, too. Therefore, categories can be assigned only so that zero or more 'bad' values are followed by zero or more 'neutral' values, which are then followed by zero or more 'good' values - in the ascending or descending direction, depending on scale order.

3.3 Continuous Scale Editor

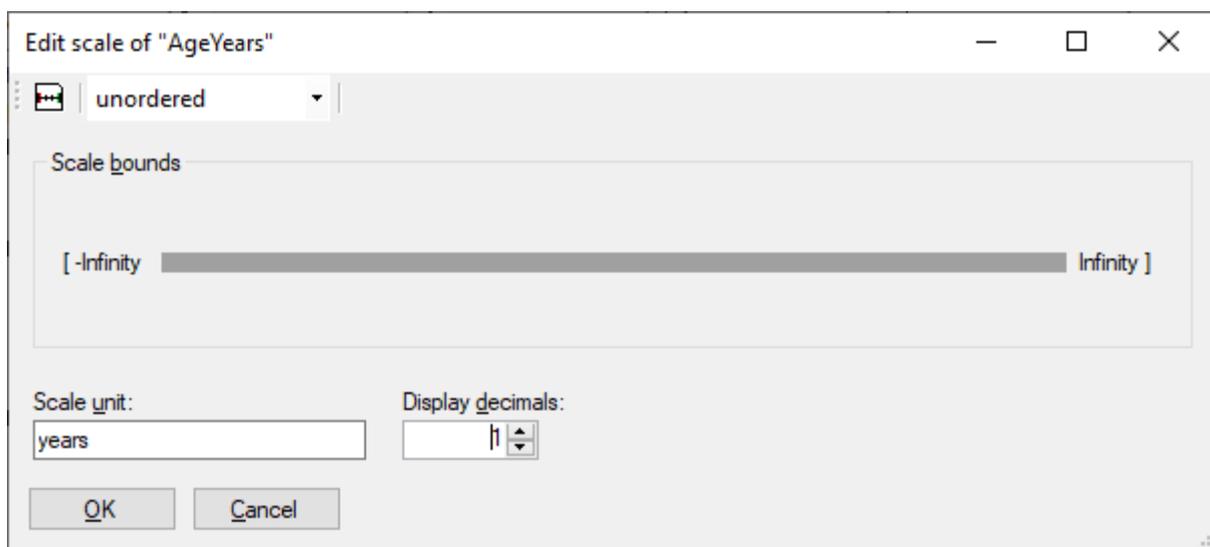
A **continuous scale** can be associated only with basic attributes that are single children of their parent attributes - that is, they have only one parent. This is required because DEX discretization functions can handle only one function argument at a time.

Editing an Ordered Continuous Scale



Dialog box titled "Edit scale of "ExperYears" showing an ascending scale. The scale bounds are defined by a red segment from $-\infty$ to the Bad threshold (input field), a grey segment between the Bad threshold and the Good threshold (input field with value 10), and a green segment from the Good threshold to ∞ . The scale unit is "years" and the display decimals are set to 2.

Editing an Unordered Continuous Scale



Dialog box titled "Edit scale of "AgeYears" showing an unordered scale. The scale bounds are defined by a single grey segment from $-\infty$ to ∞ . The scale unit is "years" and the display decimals are set to 1.

In DEX, continuous scales are considerably simpler than their qualitative counterparts. Any real (floating-point) value, including the negative and positive infinity, can be assigned to any continuous scale.

Some additional information can be provided for each scale:

- **Scale bounds** (enabled only for ordered scales): ‘bad’ and ‘good’ thresholds to define ‘bad’ and ‘good’ value intervals, respectively.
- **Scale unit** (optional): A text string representing the measurement unit.
- **Display decimals**: The number of decimals used to display values on this scale. The admissible range is -1 to 10, where -1 indicates a flexible number of decimals so as to accurately represent each individual value.

Commands

 **Edit scale value and description**: Open a separate window for editing this scale’s name and description.

Scale order: a list for defining the scale’s *preferential order*, which can be: **ascending**, **descending** or **unordered**.

Remarks

In contrast with qualitative scales, editing a continuous scale does not alter any associated functions. It may, however, affect displaying DEX values on this scale and their ‘bad’/‘good’ categories.

Ascending continuous scales are usually associated with *gain* continuous attributes (e.g. “Selling Price”), and descending scales are usually associated with *loss* attributes (e.g. “Buying Price”).

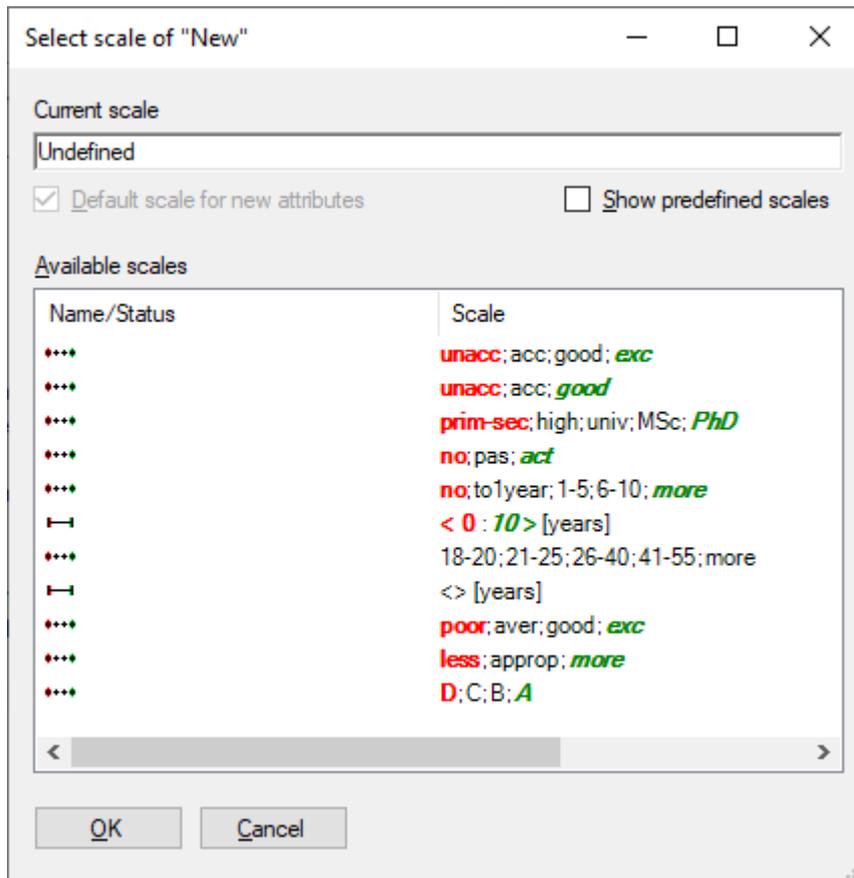
Unordered scales are generally used with continuous attributes that do not exhibit any “preferential direction” (“the lower the better” or “the higher the better”). Since unordered scales tend to be less comprehensible than the ordered ones, it is advised to reconsider unordered scales and formulating them in terms of ordered ones whenever possible.

3.4 Scale Selection Window

The *Scale Selection Window* can be activated from the *Model Page* while positioned on some attribute. Using this window, it is possible to select some scale and associate it with the selected attribute. In principle, all scales, which are currently defined in the model, are available, but subject to restrictions explained below.

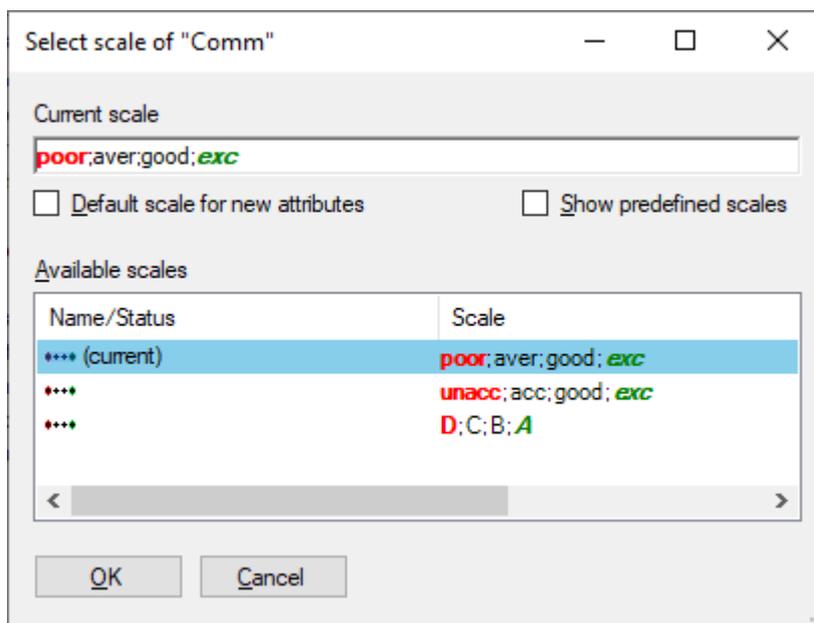
The following screenshots illustrate two examples of scale selection using the *Employee Selection* model. In both cases, the scales currently assigned to the selected attribute are displayed at the top of the window.

Selecting Scales of a Newly Created Attribute



In this case, *Test* is a newly created attribute and its scale is currently undefined. Any discrete scale (marked ****), already defined in the model, can thus be assigned to the attribute. Since *Test* is also the only child of its parent attribute, any continuous scale ([-]) can be used, too.

Selecting Scales of an Attribute With a Defined Scale



In this case, not all available scales can be assigned to the existing attribute *Comm*, whose scale contains four values, as indicated at the top of the dialogue. Only other already defined scales that also contain four values can be assigned to *Comm*.

Predefined Scales

DEXiWin provides several predefined, generally applicable value scales. These can be added to the selectable list by checking the “Show predefined scales”.



Remarks

The assignment of scales to attributes is subject to some restrictions.

The main requirement is that the assignment *must not* affect any functions that might be already defined in the neighborhood of the attribute. Another restriction is that discretization functions can have exactly one continuous child attribute. This leads to the following rules:

- Any qualitative scale can be assigned to any attribute whose scale is currently undefined.
- Some qualitative scale can be assigned to an attribute with already defined qualitative scale only if both scales have the same number of values.
- Any continuous scale can be assigned to a basic attribute that is a single parent of its parent attribute, provided that its scale is undefined or continuous, and the parent's function is undefined or of discretization type.

In the above screenshots, notice the checkbox “Default scale for new attributes”. Checking this box tells DEXiWin to automatically associate the selected scale with all newly created attributes. This speeds up the creation of attributes and avoids defining a scale explicitly for each new attribute. Of course, this functionality is useful only when the majority of scales in the model are of the same type.

3.5 Function Editor

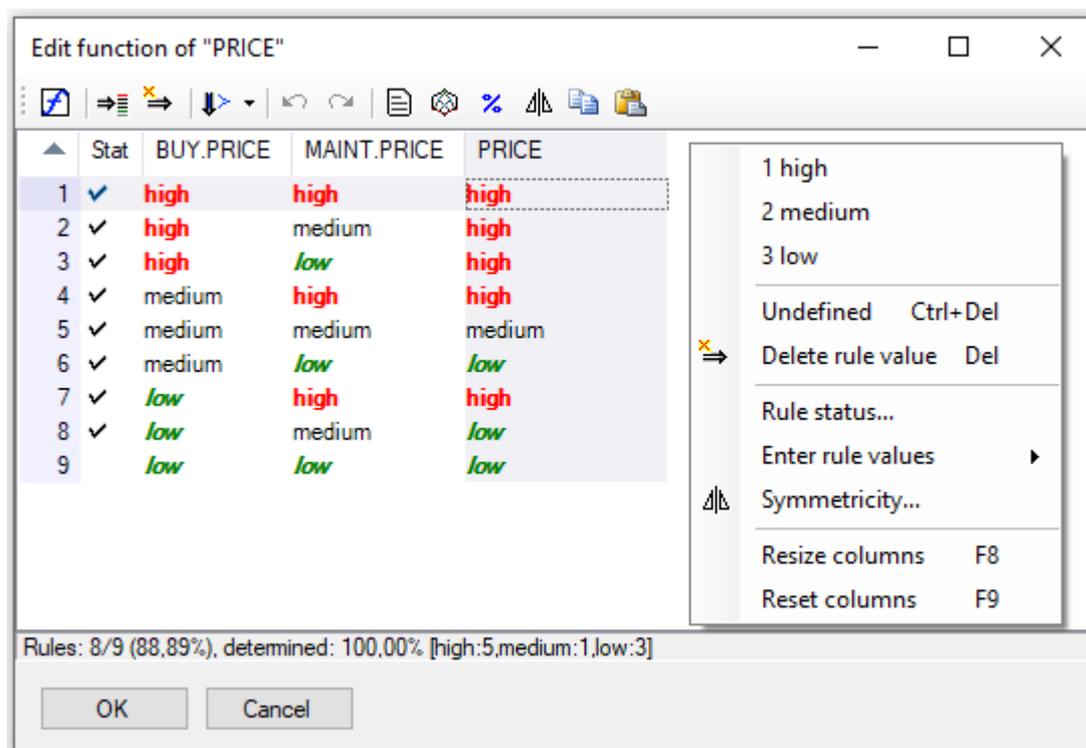
Function Editor is a window in which you can create and edit one [function](#). Since the method [DEX](#) uses two types of functions, [aggregation](#) and [discretization](#), DEXiWin provides two corresponding editors:

- *Aggregation Function Editor*
- *Discretization Function Editor*

3.6 Aggregation Function Editor

An [aggregation function](#) can be associated with any aggregate attribute that has one or more qualitative descendant attributes (“children”) in the tree. Such a function maps values of those children, which act as function arguments, to values of the parent attribute. The mapping is defined in terms of elementary decision rules; each rule defines the function value for one particular combination or arguments’ values. In DEXiWin, all possible combinations are considered and shown in a *decision table*.

The example below shows the *Aggregation Function Editor* while editing function *PRICE* from the [Car Evaluation](#) model. It shows the decision table and a pop-up menu, which is activated by right-clicking the mouse.



Decision Table

The central part of the window displays a *decision table*. Table rows contain all the possible combinations of values of function's arguments. The columns display:

- Rule number. There are as many rules as there are possible combinations of input attribute values. Some rules may be filtered out, as explained below.
- *Stat*: Decision rule status, one of the following:
 - ✓ Entered by the user
 - [no icon] Not entered by the user
 - ! Entered by the user, but inconsistent with one or more other rules
 - ! Not entered by the user, inconsistent

Clicking on the *Stat* row displays a message that explains the status - and the reasons for possible inconsistency - in more detail.

- Arguments' columns: One column per each function argument (*BUY.PRICE* and *MAINT.PRICE* above)
- Function values: A column showing output function values for the corresponding rules (*PRICE*). This is the only editable column in the table. Admissible values that can be entered by the user are:
 - a single value taken from the corresponding scale (for example: "high"), or
 - an undefined value, denoted <undefined>.

The order of columns can be rearranged by dragging and dropping column headings. Column orders and widths are retained for each decision table throughout the current DEXiWin session.

By default, non-entered rule values of preferentially ordered functions are handled by DEXiWin and recalculated each time the table has changed. Thus, while editing the table, DEXiWin may assign values

or value intervals to decision rules that have not been defined yet; see the [explanation](#). Consequently, function values are generally [intervals](#), not just single values.

You can enter a function value in one of the following ways:

- by pressing  or **F2**, and selecting an item from the list of admissible values;
- right-clicking and selecting an item from the pop-up menu; or
- pressing one of the keys **1**, **2**, **...**, on the keyboard, which represent consecutive scale values.

To delete the currently selected value, press  or **Delete**. Deletion changes rule status to “non-entered”.

Pressing **F8** adjusts table columns to the width of displayed text.

Right-clicking on a table heading that corresponds to some function argument opens up the menu *Filtering*. There, you can select input attribute values that are shown in the table. Notice that DEXiWin still processes the whole table while editing, despite that only a fraction might be displayed due to filtering.

Commands

The toolbar and/or the pop-menu provide the following commands:

 **Edit function name and description:** Open a separate window for editing this function’s name and description.

 **Edit selected rule value:** Show a drop-down list of admissible values.

 **Delete selected rule value:** Deletes the value of the currently selected rule. Deletion changes rule status to “non-entered”, which means that the calculation of its value is handed over to DEXiWin according to its settings (below). Deleting a value is *not* equal to setting it to <undefined>.

 **Choose method(s) for automatic setup of non-entered function values:** This drop-down button allows activating and deactivating DEX methods for handling [non-entered function values](#). There are two such methods:

- [Use dominance \(scale orders\)](#)
- [Use weights](#)

The status of these methods’ activation is reflected in the icon shown in the toolbar:

-  No method activated
-  *Dominance (scale orders)* method activated
-  *Weights* method activated
-  Both methods activated

 **Undo:** Undo the last function-editing operation.

 **Redo:** Redo the last undone function-editing operation.

 **Show function:** Make a report that shows the function and [preview](#) it. The default function representation is with [complex rules](#), but this can be changed in the report itself.

 **Chart:** Open *Function Chart* and display the function using a three-dimensional graphic.

 **Edit weights:** Open *Weight Editor* to define attribute weights.

 **Symmetry:** Open the *Symmetry Window* for checking and setting the symmetry of decision rules.

 **Copy function:** Copies the function into the clipboard for further use. The copied data format is the same as used in a [function file](#).

 **Paste function:** Imports previously **Copied** function into the current one. After the operation, it reports the number of imported rules (rules whose values matched between the clipboard and the current function) and the number of rules whose values actually changed. It is strongly recommended not to change *Import/Export settings* between copying and pasting a function.

Pop-Up Menu

The pop-up menu, activated by right-clicking the mouse, provides these additional commands:

Rule status...: Display the status of the currently selected decision rule.

Enter rule values...: Methods for defining values of multiple decision rules:

Whole table: Changes the status of all rules in the table from non-entered to entered. Suitable for “freezing” the entire table.

Rules having single (non-entered) values: Similar as above, but “freezing” only those rules that have been assigned a single value. Rules with undefined or interval values are left unchanged.

 **Symmetry...**: Open the *Symmetry Window* for checking and setting the symmetry of decision rules.

Resize columns [F8]: Adjust the widths of all columns in the table.

Reset columns [F9]: Table display settings (column widths and column order) are remembered throughout the current DEXiWin session. This command resets these settings to their default values.

Recommendations

Editing aggregation functions requires quite some skills and experience, particularly when decision tables are large. You may want to try some of the function editing [approaches](#).

For small tables, which consist of about up to 10 or 20 rules, it is probably most effective just to proceed sequentially through the table and enter all the values in one turn. For fast data entry, use the keyboard keys **1**, **2**, etc., and **Delete**.

For tables of intermediate size, up to 50 or maybe 100 rules, a useful approach is to combine your data entry with the [scale orders](#) strategy. In this case you “jump” across the table and enter values only for some “important” rules, such as rules having extreme values of attributes or extreme function values. [It may take some practice to learn which rules are “important”.] At the same time, you let DEXiWin calculate values of non-entered rules. In this way, you may quickly get a highly [determined](#) function. You may follow this stage by several iterations of finding unsatisfactorily defined rules and entering your values there until the function has been completely defined.

For even larger tables, you might want to additionally employ the [weights](#) strategy. Start again with entering some “important” values. Then, open *Weight Editor* and define your required attribute weights. If successful, this will fill all the non-entered cells with single values corresponding as closely as possible to your weights and already entered rules. Afterwards, do not forget to *check* what DEXiWin has done automatically. Review the assigned values and verify if they make sense. Also check the actual weights achieved in this way: run *Weight Editor* again and see the “Actual” weights.

Although DEXiWin can work with less-than-completely defined functions, it is recommended to define the functions completely. Incompletely defined functions may cause alternatives to be evaluated by sets or distributions of values rather than single values. Therefore, you should check the status of your functions and ensure that they are “100% determined” and that the corresponding icons in the *Model Page* are green.

As long as your function is “100% determined”, the proportion of actually entered rules is not that important and can be less than 100%. However, even in this case you should be aware that non-entered rules are more volatile than entered ones. Entered values are never changed by DEXiWin, but non-entered values may be unintentionally changed later, for example, by changing weights in the *Weight*

Editor. To protect your completed function from such changes, you may want to run the **Enter rule values...** command.

For final verification of your function, you may also want to review its representation in a report (**Show function** command) or *3D chart* (**Chart** command).

See Also

DEX Method documentation:

- Aggregation functions
- Representing aggregation functions
- Acquiring decision tables and decision rules
- Combinatorial explosion
- Weights

3.6.1 Weight Editor

Weight Editor facilitates viewing and defining weights of the aggregation function that is currently edited in *Function Editor*. These weights may be used to determine the values of non-entered decision rules.

Attribute	Required Weight	Required	Actual Weight	Actual
PRICE	50		60	
TECH.CHAR.	50		40	

Normalize:

Rounding: down no up

In this editor, you can set weights of input attributes by entering/editing values in the *Required Weight* column of the table shown. This is the only editable column. Editing can be invoked either by pressing **F2** or double-clicking the cell.

The remaining three columns are:

- *Required*: Graphical display of the required weights.
- *Actual Weight*: Actual attribute weights calculated from the decision table. Usually, they differ from the required ones because they are constrained by already entered rules and the discrete representation of the function, as explained below.
- *Actual*: Graphical display of the actual weights.

Buttons

Sum 100: Normalize (proportionally scale) the entered required weights so that their sum becomes 100.

Max 100: Normalize the entered required weights so that the maximal weight becomes 100.

Rounding specifies how to calculate the values of non-entered rules that fall just between two ordinal values. For example, let ordinal numbers of ‘acc’ and ‘good’ be 2 and 3, respectively. For some non-entered rule, a linear approximation formula is applied and may calculate the value 2.5. In this case, “Rounding” specifies whether this value is rounded ‘down’ to 2 (meaning ‘acc’) or ‘up’ (‘good’). The setting of ‘no’ does not favor any specific direction and leaves the rounding to the underlying arithmetic software.

Remarks

Absolute values of weights are not really important in DEXiWin; only their relative proportions matter. Both normalizations (‘Sum’ and ‘Max’) preserve relative proportions.

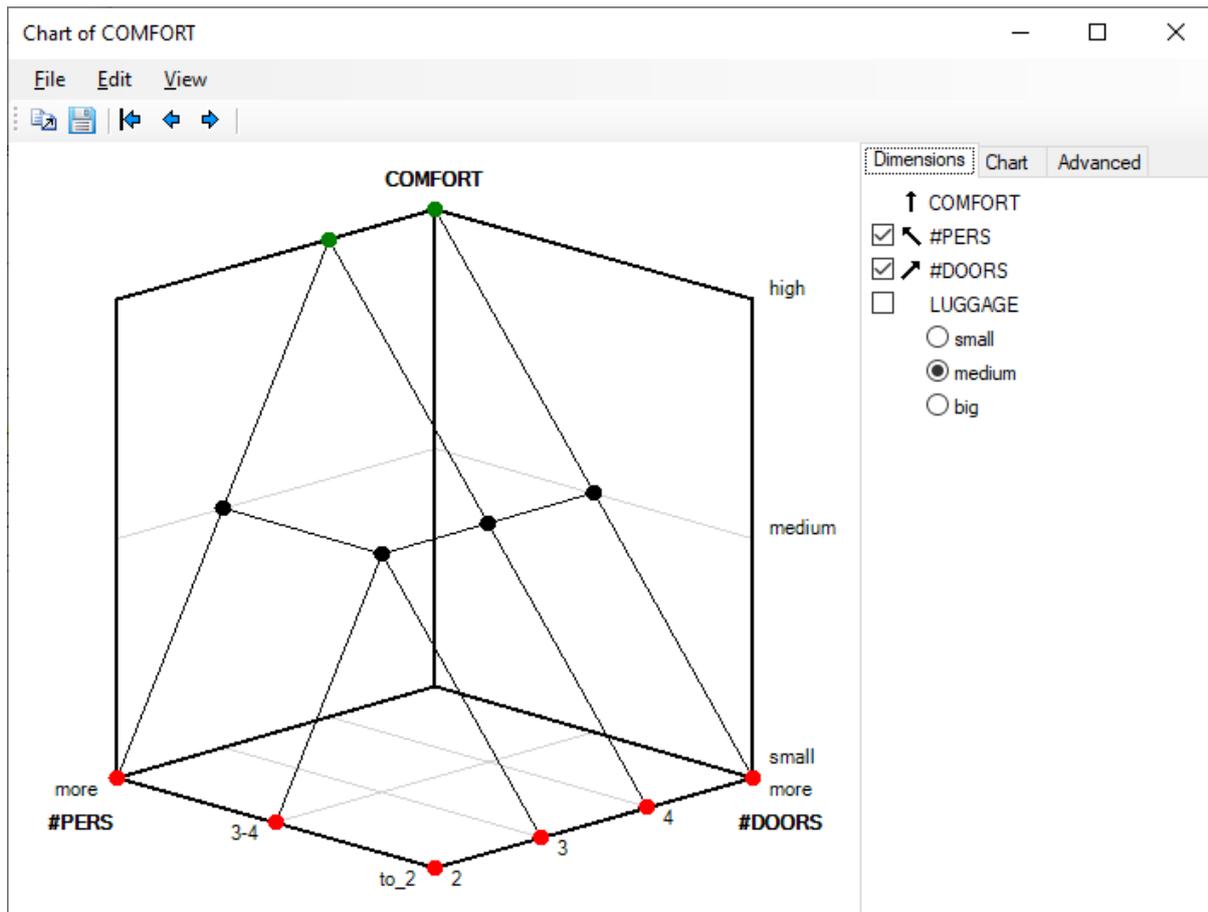
It is important to understand that “Actual” weights represent the closest possible match with your “Required” weights *and* the rules already entered in the table. In general, “Actual” weights differ from the “Required” ones for two main reasons:

- DEX aggregation functions are discrete, not continuous. For each decision rule (a function “point”) there are only a few discrete values available for assignment. In general, it is thus impossible to exactly match continuous “Required” weights with a discrete aggregation function.
- A [hyperplane](#) constructed from “Required” weights depends on already entered function values. The more the entered values, the lower the freedom for the hyperplane, and the lower the chance to match the “Required” weights. A fully defined function can not be altered using weights at all.

The “Rounding” setting ‘no’ is included for compatibility with models built by DEXi. Its use is not recommended and should be avoided in models created by DEXiWin.

3.6.2 Function Chart

Function Chart displays the current function edited in the *Aggregation Function Editor* using a three-dimensional chart. The function is displayed in a point-by-point way, where each colored dot represents one decision rule. Points are connected with lines, which serve only for visualization and are not part of the function definition.



The vertical chart axis always corresponds to the output attribute. The two ground chart axes correspond to two function arguments (two input attributes). For functions that have more than two input attributes, the chart essentially displays only a three-dimensional “intersection” through the function, using two ground attributes together with fixed values of the remaining input attributes. You can select the ground attributes and the values of the remaining attributes using the *Dimensions* control on the right panel of the window.

Arrows, which are displayed in the control area, indicate the axes used for displaying the corresponding attribute. Clicking on an arrow, you may reverse the scale shown on that axis.

The graphical display can be altered by *Chart* controls on the right panel. These include:

- defining picture borders [pixels],
- rotation along the horizontal and vertical axes [degrees],
- a button for resetting the rotation,
- buttons for setting fonts, used for displaying attributes and their values.

Also, the chart can be rotated by mouse drag-and-drop on the graphic.

Commands

The following commands are available through menu items and toolbar buttons:

 **File/Save chart...**: Save the current chart in one of two formats: Metafile (.emf) or Bitmap (.png).

 **Edit/Copy as metafile...**: Copy the current graphic to the clipboard using the metafile format.

 **Edit/Copy as bitmap...**: Copy the current graphic to the clipboard using the bitmap format.

 **View/First chart**: In the case of multiple charts (“intersections” through the function), move to the first chart in the series.

 **View/Previous chart**: Display the previous three-dimensional graphical “intersection” through the function.

 **View/Next chart**: Display the next three-dimensional graphical “intersection” through the function.

Remarks

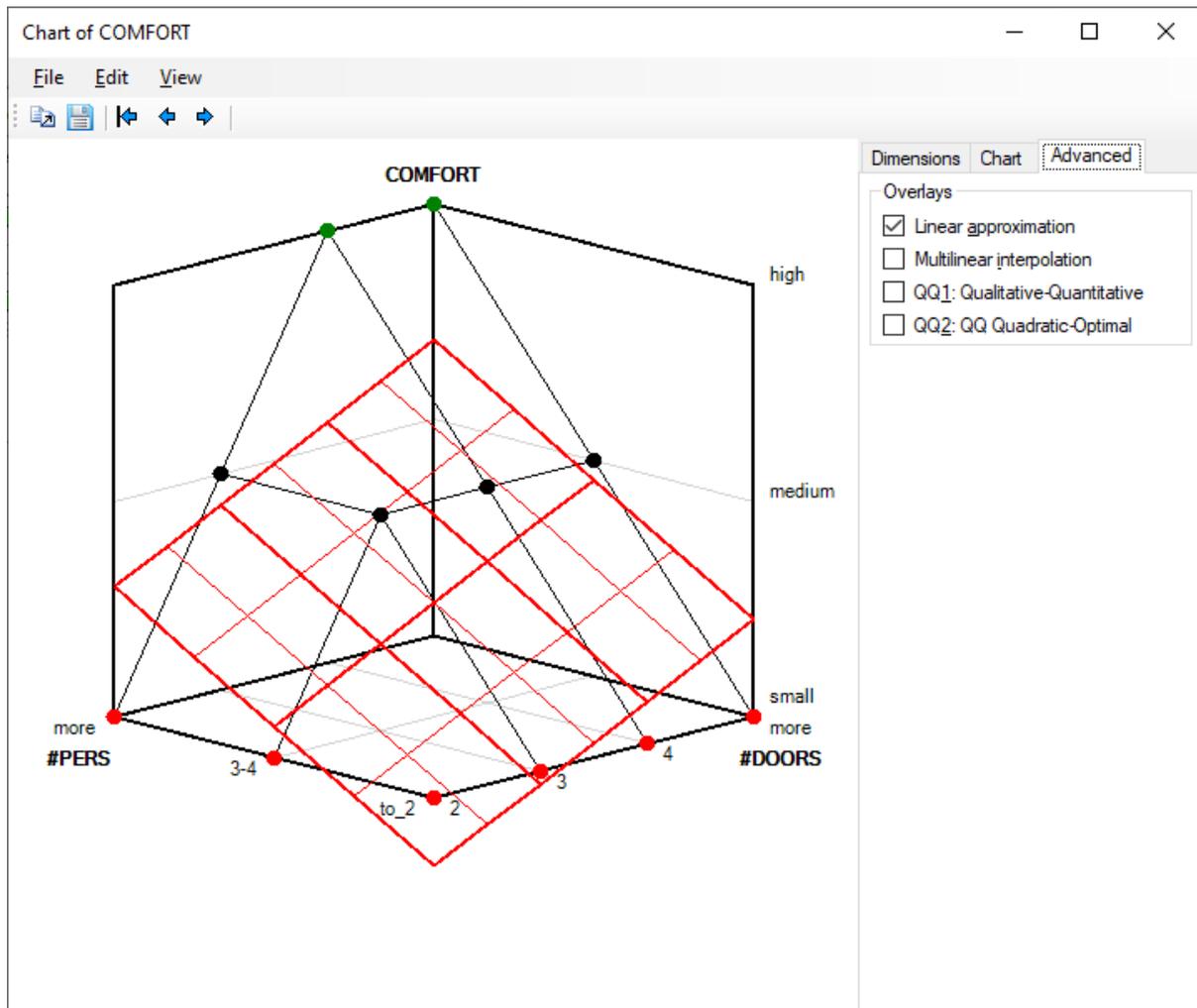
Metafile is the Windows’ vector graphic format. Usually, metafiles work better than bitmaps when pasted to Word documents or PowerPoint presentations, because they better adapt to zooming and enlarging. On the other hand, metafiles are poorly supported in environments other than Windows.

Advanced Displays

The *Advanced* tab provides some additional graphic displays of the function. One or more graphic overlays can be selected that show possible numeric interpretations of the function.

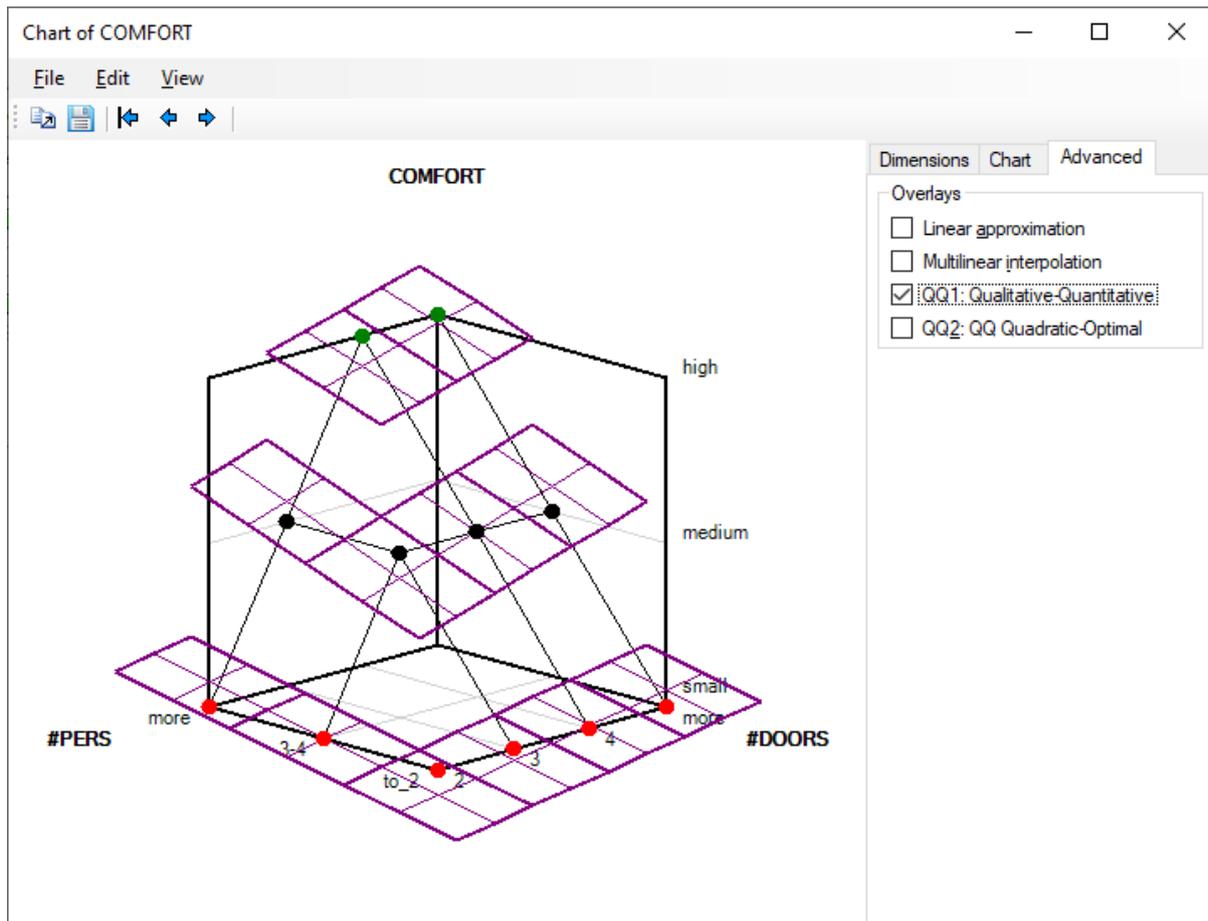
Linear approximation

This graphic overlay shows the (hyper)plane that best (in the least-squares sense) approximates individual points (elementary rules) of the function. Notice that this (hyper)plane is used to determine weights that are used in the *Weight Editor*



Multilinear interpolation

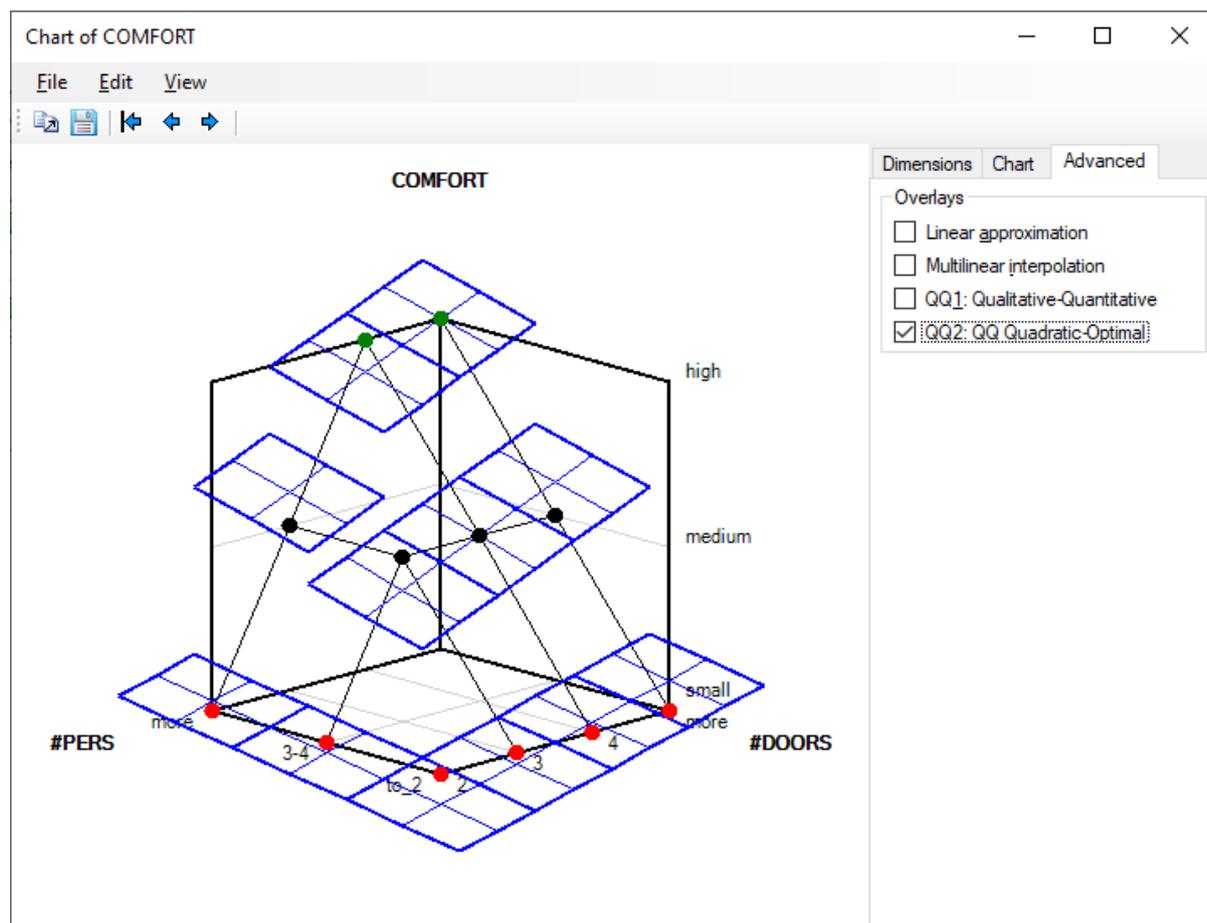
Multilinear interpolation extends discrete function points to a continuous multivariate function that exactly matches those points and smoothly interpolates the space around them. This function is constructed using the [multivariate interpolation](#) method.



The QQ1 display shows the numerical ranking function derived from rules. Each point is surrounded by a small hyperplane covering the $[-0.5, +0.5]$ range around the point. The hyperplanes are slanted according to function weights and extended vertically to cover the whole $[-0.5, +0.5]$ range of each discrete class.

Quadratic-Optimal (QQ2)

QQ2 is a new method, designed for the same purpose as QQ1, but aimed at improving some of QQ1's deficiencies. While QQ1 relies on attribute weights, QQ2 considers only the principle of dominance, which makes it more general and flexible. In order to construct hyperplanes around points of the function, QQ2 solves a quadratic optimization program, generally achieving a better vertical discrimination of ranks than QQ1. QQ2 also correctly handles unordered attributes. In this way, QQ2 is considered better than QQ1. The QQ2 method has not been published yet.



Remarks

Linear approximation and QQ1 are available only for functions that allow using weights, i.e., are defined in the space of preferentially ordered attributes.

Multilinear interpolation is available exclusively to functions that are fully determined, meaning that all their rules explicitly define a single output value.

Linear approximation is used in DEXiWin in relation with weights. Multilinear and QQ1 representations are currently just displayed and not used anywhere else in DEXiWin. QQ2 is used in Qualitative-Quantitative evaluation.

References

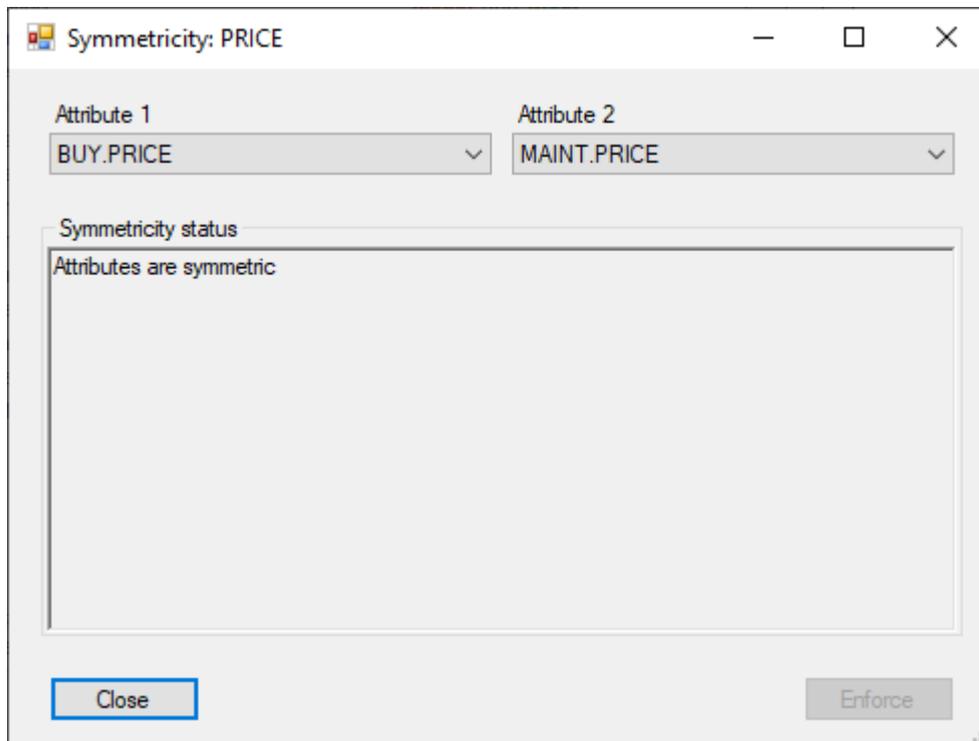
Bohanec, M., Urh, B., Rajkovič, V. (1992): Evaluating options by combined qualitative and quantitative methods. *Acta Psychologica* 80, 67–89.

3.6.3 Symmetry Window

Decision tables are often *symmetric* with respect to one or more pairs of attributes. Decision rules are said to be symmetric with respect to input attributes A and B whenever exchanging the values of those attributes yields the same output values, for all possible combinations of input values.

The *Symmetry Window* of DEXiWin serves two purposes:

- Checking whether or not the current decision table is symmetric with respect to a selected pair of input attributes.
- Enforcing the symmetry of two selected attributes by assigning values to rules that have not been entered by the user.



The above example shows that decision table *PRICE* (from the *Car* model) is symmetric with respect to the two chosen input attributes *BUY.PRICE* and *MAINT.PRICE*. Other possible outcomes of such checking might be:

- *Asymmetric attributes: different value count and/or preference order*: in cases when symmetry makes no sense and can not be determined;
- *Asymmetric rule(s)*: indicated when the attributes are not symmetric. Such message also lists indices of all rule pairs that are not symmetric.

In the latter case, when the current decision table is incompletely defined, it may happen that symmetry with respect to the chosen attributes can be established, at least partly, by assigning values to rules that have not been defined by the user. In this case, the message additionally indicates which assignments are possible, for example:

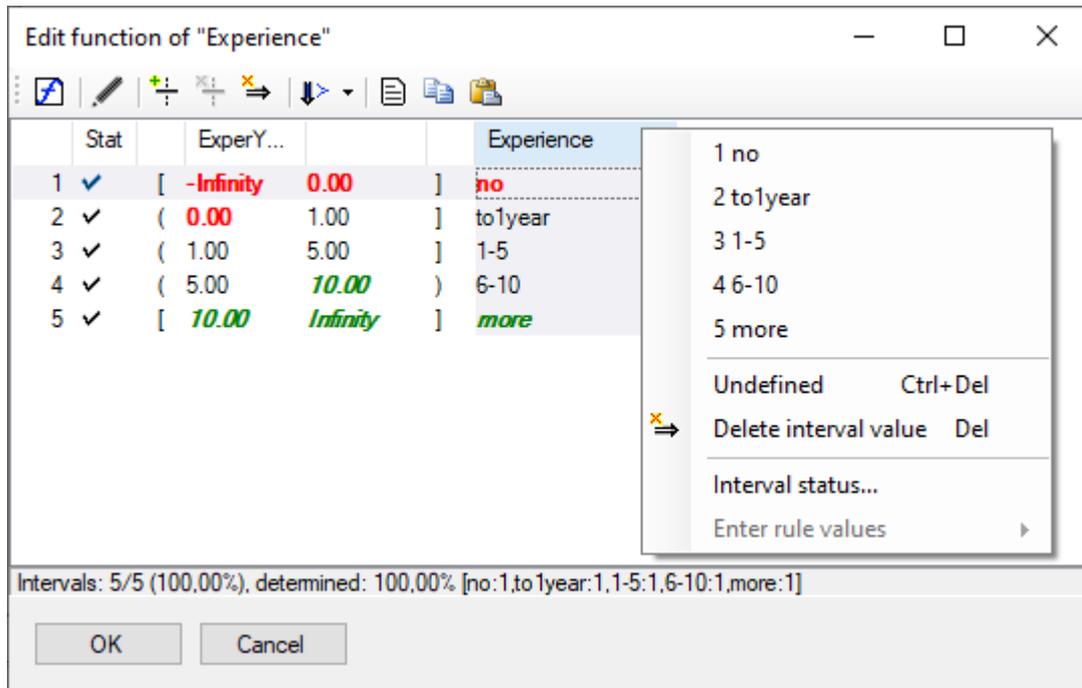
Possible assignments to enforce symmetry:
 Rule 2 --> 4
 Rule 6 --> 8

In such cases, the *Enforce* button becomes enabled and can be pressed to execute all the specified assignments.

3.7 Discretization Function Editor

A discretization function can be associated only with an attribute that has a single continuous child attribute (“function argument”). The function is aimed at mapping numeric values of the child attribute to qualitative values of the parent attribute. The mapping is represented in terms of non-overlapping intervals and function values (outputs), defined for each interval. All intervals are collected in an *interval table*.

The example below shows the *Discretization Function Editor* while editing the *Experience* function from the *Employee Selection* model. The function maps candidates’ experience, measured in years, to qualitative values no; to1year; 1-5; 6-10; more. The screenshot shows the interval table and a pop-up menu, which is activated by right-clicking the mouse.



Interval Table

The central part of the window displays an *interval table*. Each row corresponds to a single interval of *ExperYears* child attribute. The following columns are displayed:

- *Interval number*: There are one or more intervals; as many as needed can be defined.
- *Stat*: Interval status, one of the following:
 - ✓ Entered by the user
 - [no icon] Not entered by the user
 - ! Entered by the user, but inconsistent with one or more other intervals

- **!** Not entered by the user, inconsistent

Clicking on the *Stat* row displays a message that explains the status - and the reasons for possible inconsistency - in more detail.

- *Low bound association*: This column displays [or (depending on whether or not, respectively, the associated low bound belongs to this interval.
- *Low bound*: The lower bound of the interval.
- *High bound*: The upper bound of the interval.
- *High bound association*: Displays] or) depending on whether or not, respectively, the associated high bound belongs to this interval.
- *Function values*: The rightmost column shows output function values for the corresponding intervals. This is the only editable column in the table. Admissible values that can be entered by the user are:
 - a single value taken from the corresponding scale (for example: “to1year”), or
 - an undefined value, denoted <undefined>.

By default, non-entered interval values of preferentially ordered functions are handled by DEXiWin and recalculated each time the interval table has changed. Thus, while editing the table, DEXiWin may assign values or value intervals to rows that have not been defined yet. Consequently, discretization function values are generally *intervals*, not just single values.

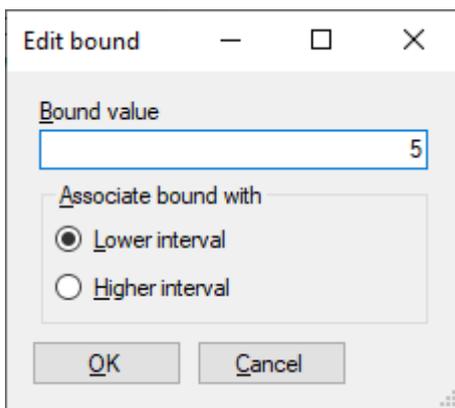
You can enter a function value in one of the following ways:

- by pressing  or **F2** while placed on the output column, and selecting an item from the list of admissible values;
- right-clicking and selecting an item from the pop-up menu; or
- pressing one of the keys **1, 2, ...**, on the keyboard, which represent consecutive scale values.

You can change bound values and associations:

- by pressing  or **F2** while placed on the corresponding interval bound; or
- by double clicking the corresponding interval bound.

These commands opens a dialogue for editing the corresponding bound and its association, as shown below.



To delete the currently selected value, press  or **Delete** . Deletion changes interval status to “non-entered”.

Commands

The toolbar and/or the pop-menu provide the following commands:

 **Edit function name and description:** Open a separate window for editing this function's name and description.

 **Edit selected cell:** Depending on the selected cell in the table, this command either shows a drop-down list for selection of admissible output values or opens the bound editing dialogue.

 **Add bound:** Open the bound editing dialogue. After confirmation, a new bound is added to the interval table and individual intervals are redefined to accommodate the change.

 **Delete bound:** Deletes the currently selected bound. Intervals adjacent to this bound are joined together and the interval table is rearranged accordingly. It is not allowed to delete the **-Infinity** and **+Infinity** bounds.

 **Choose method(s) for automatic setup of non-entered function values:** This drop-down button allows activating and deactivating the **Use dominance (scale orders)** method. The activation status is reflected in the icon shown in the toolbar:

-  Not activated
-  Activated

 **Undo:** Undo the last function-editing operation.

 **Redo:** Redo the last undone function-editing operation.

 **Show function:** Make a report that shows the function and *preview* it.

 **Copy function:** Copies the function into the clipboard for further use. The copied data format is the same as used in a *function file*.

 **Paste function:** Imports previously **Copied** function into the current one. After the operation, it reports the number of imported bounds and intervals. It is strongly recommended not to change *Import/Export settings* between copying and pasting a function.

Pop-Up Menu

The pop-up menu, activated by right-clicking the mouse, provides these additional commands:

Interval status...: Display the status of the currently selected interval.

Enter rule values...: Methods for defining values of multiple intervals:

Whole table: Changes the status of all intervals in the table from non-entered to entered. Suitable for “freezing” the entire table.

Rules having single (non-entered) values: Similar as above, but “freezing” only those intervals that have been assigned a single value. Intervals with undefined or non-single values are left unchanged.

ALTERNATIVES PAGE

The *Alternatives Page* of DEXiWin's *Model Window* provides *workspace* and *commands* for editing DEX alternatives. This includes the editing of:

- names and descriptions of alternatives,
- values assigned to input (basic) attributes of each alternative.

Attribute	A	B	C	D	E
Fomal	MSc	PhD	PhD	PhD	PhD
For.Lang	pas	act	act	act	act
Exper.Years	1.00	12.00	8.00	8.00	8.00
Age.Years	22.0	33.0	35.0	35.0	35.0
Comm	good	aver	good	exc	-
Leader	more	less	less	more	approp/0.50:
Test	B	B	C	A	A

Workspace

The *Alternatives Page* workspace consists of a table for editing alternatives' data. Each column represents an alternative. The first row displays alternatives' names and each of the remaining rows displays values assigned to one basic attribute.

Two additional columns might be displayed in the table, depending on *View Menu* settings: basic attributes' descriptions and scales, respectively.

You can select some cell in the table by clicking on it or by moving there using keyboard arrow keys. **Home** and **End** keys move the selection to the first and last row, respectively.

To enter a cell value that corresponds to a qualitative attribute, you can:

- press **F2** or double click the cell; this shows a drop-down list that allows selecting a single value;
- right-click the cell and select an item from the pop-up menu; or
- press one of the keys **1**, **2**, ..., on the keyboard, which represent consecutive scale values, or the key *****, which denotes an undefined value.

Only single values can be entered in these ways. Other value types, particularly sets and value distributions, can be entered using the *Value Editor*.

Cell values that correspond to continuous attributes can only be edited in-place in the table after pressing **F2** or double-clicking the cell.

Commands

Alternatives Page commands can be invoked by:

- Pressing a button shown on the toolbar
- Invoking some *editing command*
- Selecting an item from the pop-up menu that appears after right-clicking the mouse
- Selecting an item from the menus:
 - *File*
 - *Edit*
 - *View*
 - *Window*
 - *Help*

Alternatives Editing Commands

 **Edit alternative name and description:** Opens a separate window for editing the name and description of the currently selected alternative (table column).

 **Edit selected value:** Shows a drop-down list for entering a single value in the selected cell.

 **Open value editor:** Invokes *Value Editor* for entering any DEX-value type in the selected cell.

 **Add alternative to the left:** Inserts a new column to the left of the currently selected column. The new alternative is named “New” and all its value cells are set to `<undefined>`.

 **Add alternative to the right:** Inserts a new column to the right of the currently selected column. The new alternative is named “New” and all its value cells are set to `<undefined>`.

 **Delete selected alternative:** Deletes the alternative displayed in the currently selected table column.

 **Duplicate selected alternative:** Duplicates the currently selected alternative and places it to the right of the original column. An asterisk ‘*’ is added to the copied alternative name.

 **Move left:** Moves the currently selected column one position to the left.

 **Move right:** Moves the currently selected column one position to the right.

 **Move down:** Moves the currently selected attribute one place down.

 **Move up:** Moves the currently selected attribute one place up.

 **Reset vertical attribute order:** Reset the order of attributes to the one defined by the model structure.

 **Copy alternatives:** Copies contents of the whole table to the clipboard for further use. The copied data format is the same as used in an *alternatives file*.

 **Paste alternatives:** Inserts previously **Copied** data into the table. Existing alternatives that have the same names as pasted alternatives are overwritten by imported data. Otherwise, pasted alternatives are inserted in the model.

↶ **Undo:** Undo the last alternative-editing operation.

↷ **Redo:** Redo the last undone alternative-editing operation.

View Menu

F8 Resize columns: Adapt table columns to the actual width of displayed text.

Description: Display or hide the *Description* column in the alternatives' table.

Scale: Display or hide the *Scale* column in the alternatives' table.

Alternatives...: Opens a sub-menu that allows displaying or hiding individual alternatives.

Remarks

Duplicating columns is very useful for “what-if” analysis: duplicate an alternative, then leave the original intact and modify only its copy. In this way, you can easily compare the effects of changes on the *Evaluation Page*.

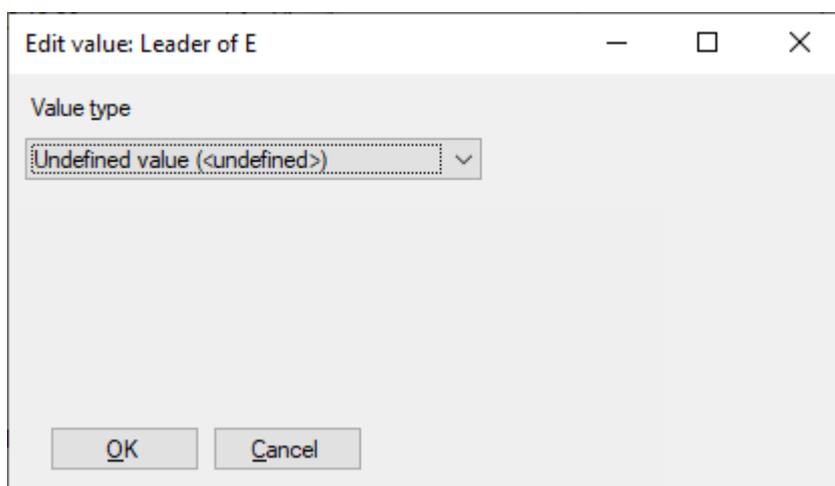
4.1 Value Editor

Value Editor allows editing any DEX-value type. It is activated from the *Alternatives* or *Evaluation Page* while attempting to change a value assigned to some qualitative basic DEX attribute. Any of the following value types can be assigned to any qualitative basic attribute:

- *undefined value*
- *single value*
- *value set*
- *value distribution*

Value type can be selected using the top-most drop-down button shown in *Value Editor*. The editor contents adapts accordingly. When switching between different value types, the editor tries to preserve any previously defined information and carries it to the new type, whenever possible.

Undefined Value



<undefined> is a primitive value type, indicating that some value has not been determined yet or is unknown to the level that cannot be represented by some other value type. This is an initial value for new alternatives. Any operation involving <undefined> yields an <undefined> result. Before *evaluation*, an undefined value may be, depending on *evaluation settings*, interpreted as a full value set.

Single Value

The screenshot shows a dialog box titled "Edit value: Leader of E". It has a "Value type" dropdown menu set to "Single value". Below it, under the "Value" section, there are three radio buttons: "less" (unchecked), "approp" (checked), and "more" (unchecked). At the bottom, there are "OK" and "Cancel" buttons.

Single value is the most common DEX value type. It consists of a single value taken from the corresponding attribute's qualitative value scale ("approp" in the above example). Values of this type are usually entered directly on the *Alternatives* and *Evaluation* Pages.

Value Set

The screenshot shows a dialog box titled "Edit value: Leader of E". It has a "Value type" dropdown menu set to "Value set". To the right of the dropdown are two buttons: "Full range" and "Clear all". Below it, under the "Value" section, there are three radio buttons: "less" (unchecked), "approp" (checked), and "more" (checked). At the bottom, there are "OK" and "Cancel" buttons.

A value set consists of zero or more values taken from the corresponding attribute's qualitative value scale ("approp" and "more" in the above example). All values from the set are considered when evaluating alternatives.

There are two special subsets, which can be assigned to the edited value using the buttons:

- **Full range:** The set of all values (often denoted *)
- **Clear all:** The empty set. In DEXiWin evaluations, the empty set is interpreted as the full set.

Value Distribution

Value	Membership
less	0
approp	0.5
more	0.5

This is the most general DEX value type that includes all other types as special cases. A distribution is composed of *value/membership* pairs, where:

- *value* is some discrete value from the corresponding attribute's qualitative scale, and
- *membership* is a numeric value, normally in the $[0,1]$ interval, which can be interpreted either as a probability or fuzzy set membership.

In the table, membership values can be edited after pressing **F2** or double-clicking the cell.

Two assignments can be made using the buttons:

- **Full range**: Assign 1.0 to all value memberships (corresponds to the full set)
- **Clear all**: Assign 0.0 to all value memberships (corresponds to the empty set)

Entered membership values can be normalized using the buttons:

- **Sum 1**: Proportionally scale the values so that their sum becomes 1
- **Max 1**: Proportionally scale the values so that their maximum becomes 1

The former normalization is better suited for probabilistic, and the latter for fuzzy interpretation of value distributions.

EVALUATION PAGE

The primary functionality of the *Evaluation Page* of DEXiWin's *Model Window* is to display evaluation results and facilitate the analysis of alternatives. Additionally, it supports all the alternative-editing operations that are primarily available on the *Alternatives Page*. Essentially, the *Alternatives* and *Evaluation* pages differ only in that the former considers only basic attributes and input data, while the latter extends this to all model attributes and focuses on the evaluation and analysis aspects of the process.

Attribute	A	B	C	D	E
Employ	good	unacc	unacc	exc	unacc/0.25; exc/0.75
Educat	acc	good	good	good	good
Formal	MSc	PhD	PhD	PhD	PhD
For.Lang	pas	act	act	act	act
Years	acc	good	good	good	good
Experience	to1year	more	6-10	6-10	6-10
Exper.Years	1.00	12.00	8.00	8.00	8.00
Age	21-25	26-40	26-40	26-40	26-40
Age.Years	22.0	33.0	35.0	35.0	35.0
Personal	good	unacc	unacc	good	unacc/0.25; good/0.75
Ablitt	good	unacc	unacc	good	unacc/0.25; acc/0.38; good/0.38
Comm	good	aver	good	exc	*
Leader	more	less	less	more	approp/0.50; more/0.50
Test	B	B	C	A	A

Workspace

The *Evaluation Page* workspace consists of a table that displays values corresponding to all attributes in the model, both basic and aggregate. The table displays the tree structure of attributes and allows collapsing and expanding aggregate sub-trees, similarly as on the *Model Page*. Values of basic attributes can be edited in the same way as on the *Alternatives Page*.

Two additional columns might be displayed in the table, depending on *View Menu* settings: basic attributes' descriptions and scales, respectively.

You can select some cell in the table by clicking on it or by moving there using keyboard arrow keys. **Home** and **End** keys move the selection to the first and last row, respectively.

To enter a cell value that corresponds to a qualitative basic attribute, you can:

- press **F2** or double click the cell; this shows a drop-down list that allows selecting a single value;
- right-click the cell and select an item from the pop-up menu; or
- press one of the keys **1, 2, ...**, on the keyboard, which represent consecutive scale values, or the key *****, which denotes an undefined value.

Only single values can be entered in these ways. Other value types, particularly sets and value distributions, can be entered using the *Value Editor*.

Cell values that correspond to continuous basic attributes can only be edited in-place in the table after pressing **F2** or double-clicking the cell.

Alternatives are re-evaluated automatically after changing any input value.

Values of aggregate attributes cannot be edited, because they are calculated by DEXiWin.

Commands

Evaluation Page commands can be invoked by:

- Pressing a button shown on the toolbar
- Invoking some *editing command*
- Selecting an item from the pop-up menu that appears after right-clicking the mouse
- Selecting an item from the menus:
 - *File*
 - *Edit*
 - *View*
 - *Analysis*
 - *Window*
 - *Help*

Evaluation Editing Commands

 **Edit alternative name and description:** Opens a separate window for editing the name and description of the currently selected alternative (table column).

 **Edit selected value:** Shows a drop-down list for entering a single value in the selected cell.

 **Open value editor:** Invoke *Value Editor* for entering any DEX-value type in the selected cell.

 **Add alternative to the left:** Inserts a new column to the left of the currently selected column. The new alternative is named “New” and all its value cells are set to <undefined>.

 **Add alternative to the right:** Inserts a new column to the right of the currently selected column. The new alternative is named “New” and all its value cells are set to <undefined>.

 **Delete selected alternative:** Deletes the alternative displayed in the currently selected table column.

 **Duplicate selected alternative:** Duplicates the currently selected alternative and places it to the right of the original column. An asterisk “*” is added to the copied alternative name.

 **Move left:** Moves the currently selected column one position to the left.

 **Move right:** Moves the currently selected column one position to the right.

 **Copy alternatives:** Copies contents of the whole table to the clipboard for further use. The copied data format is the same as used in an *alternatives file*.

 **Paste alternatives:** Inserts previously **Copied** data into the table. Existing alternatives that have the same names as pasted alternatives are overwritten by imported data. Otherwise, pasted alternatives are inserted in the model.

 **Undo:** Undo the last alternative-editing operation.

 **Redo:** Redo the last undone alternative-editing operation.

View Menu

 **Expand all:** Fully expand tree view and show all attributes.

 **Expand one level:** Extends the display of the tree by expanding the inner-most collapsed sub-trees by one level.

 **Collapse all:** Fully collapse tree view so that only root attributes are displayed.

 **Collapse one level:** Collapses the display of the tree by one level.

F8 Resize columns: Adapt columns of the workspace to the actual width of displayed text.

Description: Display or hide the *Description* column in the alternatives' table.

Scale: Display or hide the *Scale* column in the alternatives' table.

Alternatives...: Opens a sub-menu that allows displaying or hiding individual alternatives.

Analysis Menu

The following four buttons and menu commands provide shortcuts to alternative-analysis methods available in the *Analysis Menu*:

 **Selective explanation:** Identifying particular advantages and disadvantages of an alternative.

 **Plus/Minus Analysis:** Investigating the effects of changing single basic attribute values by one or more steps up and down.

 **Target analysis:** Investigating the changes of multiple input values that may improve or degrade an alternative.

 **Compare alternatives:** Compare an alternative with one or more other alternatives.

 **Qualitative-Quantitative evaluation:** Combined discrete-numeric evaluation of alternatives.

Analysis Menu

The *Analysis Menu* is available from the *Evaluation Page*. This menu provides commands for the analysis of alternatives. Each command creates and *previews* a corresponding analysis report.

DEXiWin facilitates four analyses:

 **Selective explanation:** Displays particularly *strong* and *weak* values of the currently selected alternative. This method finds and displays all connected subtrees of attributes whose values are either all of a 'good' (for strong points) or 'bad' category (for weaknesses). Before making the report, DEXiWin displays the *Report parameters* dialogue in which it is possible to define: the root attribute for selective explanation, the selection of attributes to be included in the report, considered alternatives and general report format settings.

 **Plus/Minus Analysis:** This analysis investigates the effects of changing each basic attribute by one or more values down and/or up, if possible, independently of other attributes. By default, the analysis is carried out for the currently selected alternative and displays the effects of changes on the currently selected aggregate attribute. Before making the report, DEXiWin displays the *Report parameters* dialogue with possible selections of: the root (target) attribute of the analysis, the considered alternative,

the maximum number of value steps in each direction, the selection of attributes to be included in the report, and general report format settings.

 **Compare alternatives:** This command creates a report that is similar to the common *Evaluation results* report, except that it highlights differences between alternatives. In the dialogue, which is shown before making the comparison, you can choose: the primary alternative, whether or not to show comparison operators, the list of secondary alternatives, the list of attributes to be considered, and general report format settings. On this basis, DEXiWin makes a report in which it compares the primary alternative with each secondary one. Primary alternative values are displayed in full, whereas the secondary alternatives' values are displayed only when different from the primary ones. When showing comparison operators, displayed secondary values are prefixed with operators '<', '<=', '=', '>=', '>' and '?'. They represent the preferential comparison relation between the primary and each secondary alternative's value. '?' denotes that values are incomparable. The operators '<=' and '>=' denote "weak preferences": even though the primary and secondary values are equal, the evaluations on lower levels are different and indicate a possible preferential difference.

 **Target analysis:** Tries to find combinations of input values that either improve or degrade the selected output value of the currently selected alternative. In comparison with selective explanation, which considers only changes of a single attribute at a time, target analysis performs an exhaustive combinatorial search for multi-value changes of multiple input attributes. Before making a report, DEXiWin displays the *Report parameters* dialogue in which you can define:

- *Goal attribute* and *Alternative* to be considered.
- *Try to:* Direction of the analysis, that is whether to improve or degrade the current value.
- *Selection of attributes* whose values are modified in the analysis.
- *Max. steps:* The maximum number of value steps to be checked at all the selected attributes.
- *Unidirectional:* When enabled, only unidirectional value changes are checked, i.e., only up when trying to improve the goal value and only down when degrading. Notice that with disabled *Unidirectional* setting, the goal value can be improved by improving values of some attributes, while at the same time degrading values of some other attributes. The latter is often not interesting nor desired.
- *Max. generate:* Maximum number of generated solutions. Target analysis involves a combinatorial search algorithm that may eventually generate a huge number of solutions. This parameter limits the search to a reasonable number and reduces the execution time.
- *Max. show:* Maximum number of solutions shown in the report. This parameter further limits the number of solutions that are actually included in the report.

Report parameters

Parameters Format

Goal attribute CAR

Alternative Car1

Current value *exc*

Try to improve degrade

the current value by modifying the selected attributes:

- PRICE
 - BUY.PRICE
 - MAINT.PRICE
- TECH.CHAR.
 - COMFORT
 - #PERS
 - #DOORS
 - LUGGAGE
 - SAFETY

Changing attribute values

Max. steps 1 Unidirectional

Limit the number of solutions

Max. generate 500

Max. show 10

OK Cancel

Σ_q^q **Qualitative-Quantitative evaluation:** Displays results of Qualitative-Quantitative evaluation of alternatives. Each evaluation result is represented by an *offset value*, which consists of a qualitative value and a numeric offset in the range [-0.5, +0.5]. Numeric offsets are determined using the *QQ2* method. The higher the numeric offset, the better the evaluation relative to other evaluations of the same attribute.

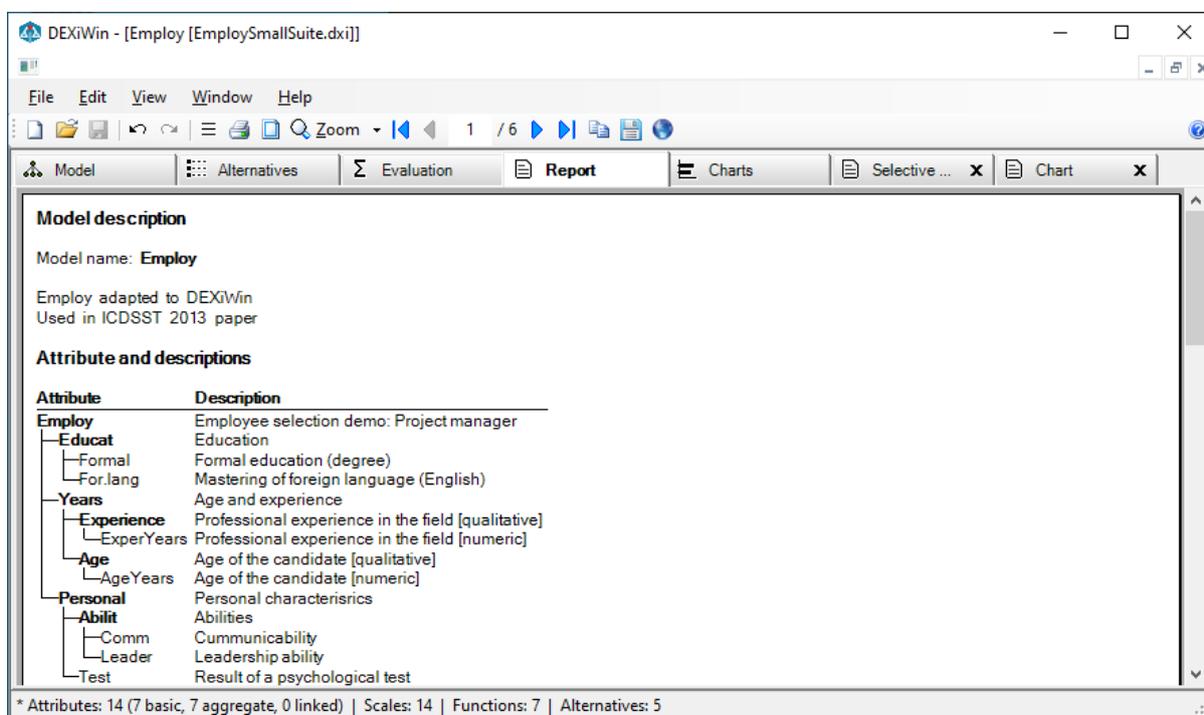
See also

Example analyses carried out using the [Car Evaluation](#) and [Employee Selection](#) models.

REPORT PAGE

DEXiWin's *Report Page* is used to display and compose *reports*. There is one *main report page*, which is shown at all times and cannot be closed. Additional *temporary report pages* can be created interactively in order to display different dynamically created reports. Temporary report pages can be closed when not needed any more.

The contents of each report page is updated whenever brought into view by selecting the corresponding tab on the *Model Window*.



Workspace

Report contents can be displayed in two different ways, depending on *settings*:

- *Document format*: Shows a document consisting of one or more pages that can be viewed and exported to text and HTML files. Individual pages can be copied as bitmap or metafile graphics to the clipboard or saved on a file.
- *HTML format*: Shows an HTML document, consisting of a sequence of report elements. In addition to showing it in the workspace, this document can be exported in a HTML format only and viewed in browsers, either *internally* in DEXiWin or in a system browser.

Because of technical limitations, document format is not available on systems without at least one printer installed. Otherwise, only HTML format is available, regardless of *settings*.

Commands

Report Page menu commands and toolbar buttons depend on the format of the displayed report.

Document Format Commands

 **File/Save report...**: Saves complete contents of the current report on one or more files, offering a choice between four formats: HTML, Text, Bitmaps, and Metafiles. The former two formats save the report on one file, while the latter two formats write series of one or more consecutively numbered graphic files, each holding one report page.

 **File/Print...**: Prints the current report.

 **File/Page setup...**: Opens a *Page Setup* dialogue in which you can define paper size used for printing, portrait or landscape orientation, and four page margins: left, right, top, and bottom.

 **Edit/Report settings...**: Opens *Report Manager*, a window for adding, editing and deleting elements of the current report.

 **Edit/Copy report page...**: Copies the currently displayed report page to the clipboard, in one of the following ways:

 **Copy as metafile**: Using the metafile graphic format.

 **Copy as bitmap**: Using the bitmap graphic format.

Crop as metafile and **Crop as bitmap**: These commands copy only graphic contents, while removing all bordering white space; this is useful for creating graphics to be inserted in other documents.

 **View/Zoom...**: Adjusts the zoom level of the document. In addition to some predefined zoom percentages (from 5% to 500%), standard zoom levels can be selected:

-  Actual size
-  Show full page
-  Show full page width
-  Show two pages side by side

 **Open report in browser**: Shows the current report in the *internal* or system browser, depending on *settings*.

The following toolbar buttons are provided for **navigation** between report pages:

-  Go to the first page
-  Go to the previous page
-  Go to the next page
-  Go to the last page

To go directly to some page, type the page number in the edit box located on the toolbar.

HTML Format Commands

 **File/Save report...**: Saves complete contents of the current report on a file, using the HTML format.

 **File/Print preview...**: Opens a HTML print preview form, which allows some adjustments of the page, possibly followed by printing the document.

File/Print...: Prints the current report.

 **Edit/Report settings...**: Opens *Report Manager*, a window for adding, editing and deleting elements of the current report.

 **View/Zoom...**: Adjusts the zoom level of the document. Three options are possible:

- Zoom in
- Zoom out
- Reset to the original zoom level

 **Open report in browser**: Shows the current report in the system browser.

6.1 Reports

Reports provide formatted and mostly textual presentations of key components of the current *DEXi model*. In DEXiWin, reports can be viewed at different places:

- On a *Report Page*. DEXiWin's *Model Page* can contain one or more report pages:
 - The main *Report Page* is fixed and is shown at all times; it contains the “main” report associated with the current model.
 - Zero or more additional report pages, which typically show some specific report *elements*. These reports are temporary; they can be created interactively and closed when not needed any more.
- In a *Preview Window*, which is displayed after invoking some command, such as one of the *analysis* commands on the *Evaluation Page*.

Depending on *settings* settings, reports are displayed in one of the following ways:

- In a *Preview Window*. The report is shown in a form of a document, which can be viewed page-by-page and exported to text and HTML files. Individual pages can be copied as bitmap or metafile graphics to the clipboard or saved on a file.
- In an *Internal Browser*. The report is shown in the HTML format internally in DEXiWin.
- In your default system browser, using the HTML format.

6.2 Report Elements

DEXiWin reports consist of zero or more *report elements*, each of which presents some viewpoint on the contents of the current DEXi model. Each element is associated with specific *Report parameters*, which define the element's contents in more detail, for example, which attributes and/or alternatives to consider.

For most of reports other than the *main one*, whose contents and settings are predefined, the *Report parameters* window is shown prior to making and displaying the report, so that the detailed settings can be provided in advance. Report parameters of each already displayed element can be edited, too.

The following types of report elements are available in DEXiWin:

6.2.1 Model description

Name and textual description of the current model, if defined. Example:

Model description

Model name: **Car**

6.2.2 Model statistics

Statistics of the current model and its components. Example:

Model statistics

Model dimensions

Depth	3
Average width	2,2500
Min	2
Max	3

Attributes 10

Basic	6
Aggregate	4

Scales 10

Discrete	10
----------	----

Functions 4

Tabular	4
---------	---

Average size 16,5000

Min 9

Max 36

Alternatives 2

6.2.3 Attribute information

This is a generic report element that traverses the whole model in a depth-first order and displays selected information about each attribute: attribute name, description, scale and/or function. In *Report parameters*, it is additionally possible to specify the root attribute for traversing the tree, format of aggregation functions display, and the list of considered attributes.

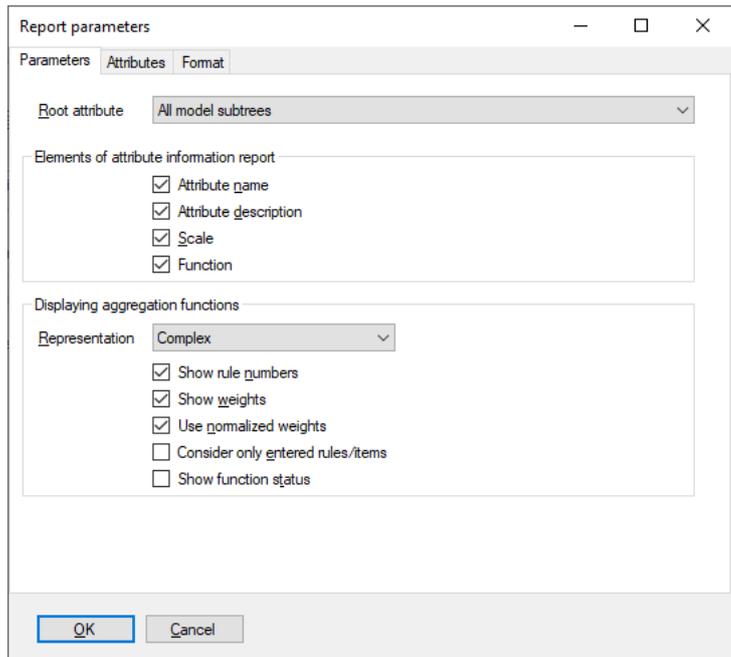
Attribute information

Attribute: **CAR**

Quality of a car

- 1 **unacc** unacceptable car
- 2 **acc** acceptable, but I won't like it
- 3 **good** satisfies my needs
- 4 **exc** excellent car

	PRICE	TECH.CHAR.	CAR
	50%	50%	
1	high	*	unacc
2	*	bad	unacc
3	medium	acc	acc
4	medium	good	good
5	low	acc	good
6	low	>=good	exc
7	>=medium	exc	exc

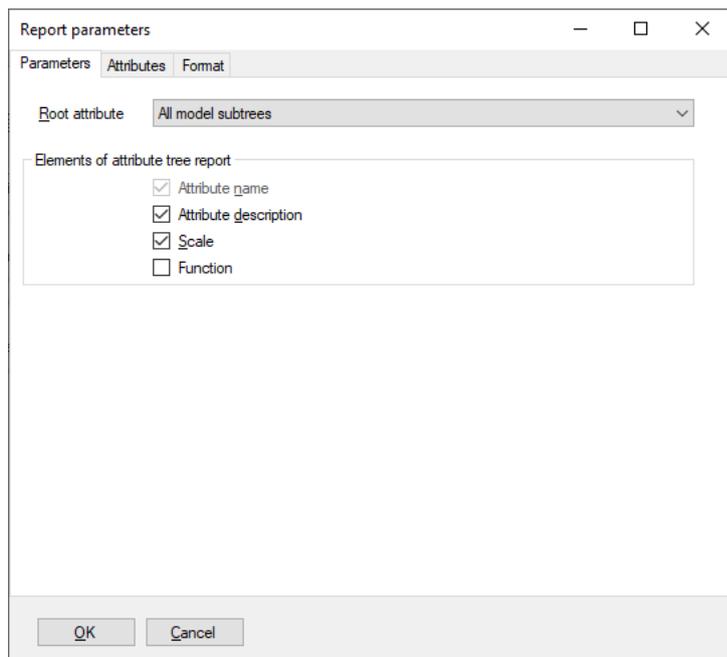


6.2.4 Attribute tree

This is another generic report element that consists of a tree structure of attributes, displayed on the left side, together with one or more columns of information shown on the right. The information is selectable and can contain: attribute description, scale and function summary. In *Report parameters*, it is additionally possible to specify the root attribute and select attributes to be included in the report.

Attribute tree

Attribute	Description	Scale
CAR	Quality of a car	unacc ; acc; good; exc
PRICE	Price of a car	high ; medium; low
BUY.PRICE	Buying price	high ; medium; low
MAINT.PRICE	Maintenance price	high ; medium; low
TECH.CHAR.	Technical characteristics	bad ; acc; good; exc
COMFORT	Comfort	small ; medium; high
#PERS	Maximum number of passengers	to_2 ; 3-4; more
#DOORS	Number of doors	2 ; 3; 4; more
LUGGAGE	Size of the luggage boot	small ; medium; big
SAFETY	Car's safety	small ; medium; high



There are three specific instances of *Attribute tree*, named:

- **Attribute descriptions:** Attribute tree displaying attribute descriptions.
- **Scales:** Attribute tree displaying attribute scales.
- **Function summary:** Attribute tree displaying function summaries.

6.2.5 Function information

Similar to *Function summary* above, but more structured, displaying information about functions in four columns, as shown below.

Function information

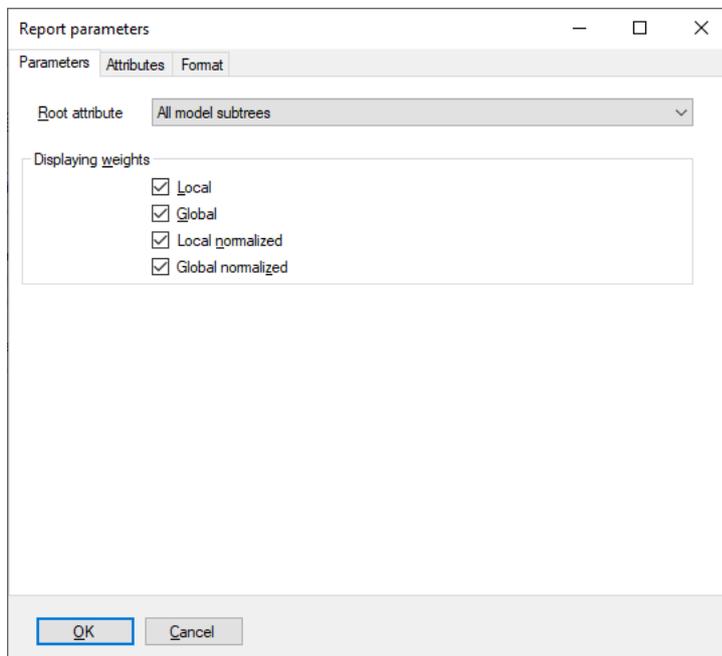
Attribute	Items	Defined	Determined	Values
CAR	12/12	100,00	100,00	unacc:6,acc:1,good:2,exc:3
PRICE	8/9	88,89	100,00	high:5,medium:1,low:3
BUY.PRICE				
MAINT.PRICE				
TECH.CHAR.	9/9	100,00	100,00	bad:5,acc:1,good:2,exc:1
COMFORT	36/36	100,00	100,00	small:24,medium:5,high:7
#PERS				
#DOORS				
LUGGAGE				
SAFETY				

6.2.6 Weights tree

Similar to *Attribute tree*, but showing weights of attributes. Four types of weights can be selected for display: local, global, local normalized, and global normalized. Additionally, the root attribute and considered attributes can be selected in *Report parameters*.

Average weights

Attribute	Local	Global	Loc.norm.	Glob.norm.
CAR				
PRICE	60	60	50	50
BUY.PRICE	50	30	50	25
MAINT.PRICE	50	30	50	25
TECH.CHAR.	40	40	50	50
COMFORT	50	20	50	25
#PERS	39	8	35	9
#DOORS	22	4	29	7
LUGGAGE	39	8	35	9
SAFETY	50	20	50	25

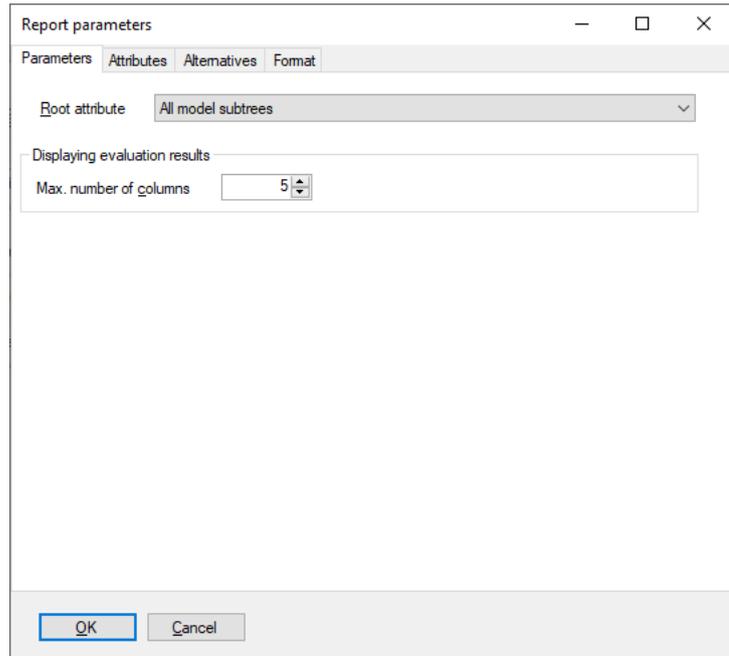


6.2.7 Alternatives

A table of alternatives' input data. This element shows the list of basic attributes on the left, followed by one or more alternatives, one column per alternative. In *Report parameters*, it is possible to specify the root attribute, maximum number of data columns per table, and select attributes and alternatives to include in the report. When there are more alternatives than the maximum number of columns, they are displayed in multiple tables.

Alternatives

Attribute	Car1	Car2
BUY.PRICE	medium	medium
MAINT.PRICE	<i>low</i>	medium
#PERS	<i>more</i>	<i>more</i>
#DOORS	4	4
LUGGAGE	<i>big</i>	<i>big</i>
SAFETY	<i>high</i>	medium

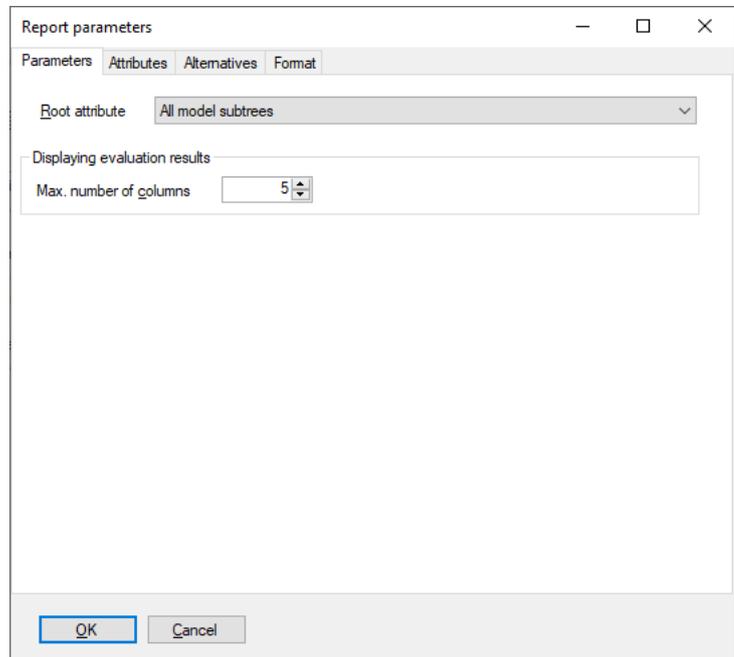


6.2.8 Evaluation results

Results of alternatives' evaluation, presented in tabular form that is a combination of *Attribute tree* and *Alternatives*. An attribute structure on the left is followed by one or more alternatives on the right, one column per alternative. In *Report parameters*, it is possible to specify the root attribute, maximum number of data columns per table, and select attributes and alternatives to include in the report. When there are more alternatives than the maximum number of columns, they are displayed in multiple tables.

Evaluation results

Attribute	Car1	Car2
CAR	<i>exc</i>	good
PRICE	<i>low</i>	medium
BUY.PRICE	medium	medium
MAINT.PRICE	<i>low</i>	medium
TECH.CHAR.	<i>exc</i>	good
COMFORT	<i>high</i>	<i>high</i>
#PERS	<i>more</i>	<i>more</i>
#DOORS	4	4
LUGGAGE	<i>big</i>	<i>big</i>
SAFETY	<i>high</i>	medium



6.2.9 Function Report Element

Function report element can be created from the *Aggregation Function Editor*, invoking the *Show Function command*. This element shows the currently edited function in one of three representations: with elementary or complex rules, or decision trees. Additionally, *Report parameters* allow to specify whether or not:

- to show rule numbers,
- to include attribute weights,
- to use normalized weights (instead of local ones),
- to display only entered (defined) decision rules,
- to show function status, including warnings about inconsistencies and other possible problems in function definitions,
- to show numerical evaluations associated with individual elementary rules: Linear approximation, QQ1 and QQ2 (see *Advanced Charts*); applies only when displaying elementary rules,
- to show marginal values: numeric representation of input attributes' qualitative values, as determined from the corresponding function.

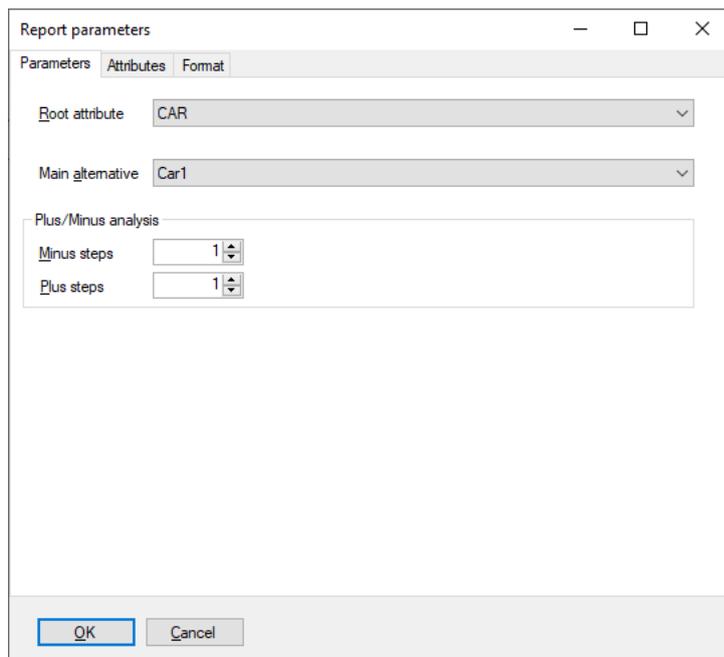
	PRICE	TECH.CHAR.	CAR
	50%	50%	
1	high	*	unacc
2	*	bad	unacc
3	medium	acc	acc
4	medium	good	good
5	low	acc	good
6	low	>=good	exc
7	>=medium	exc	exc

6.2.10 Analysis Report Elements

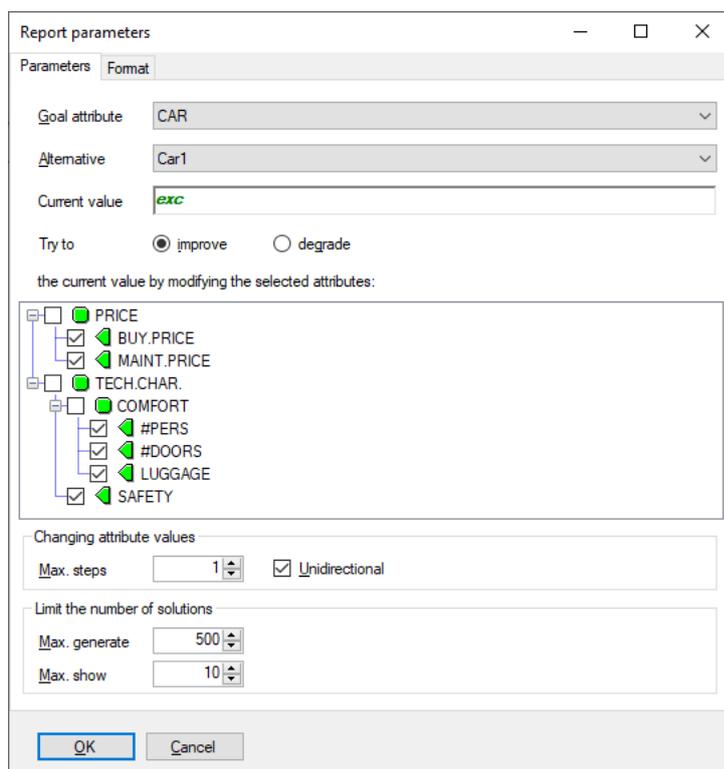
The following report elements can be created from the *Evaluation Page*, invoking one of the *analysis* commands:

Selective explanation: Presenting results of selective explanation: displaying strong and weak points of alternatives. *Report parameters* allow the selection of the root attribute and the lists of considered attributes and alternatives.

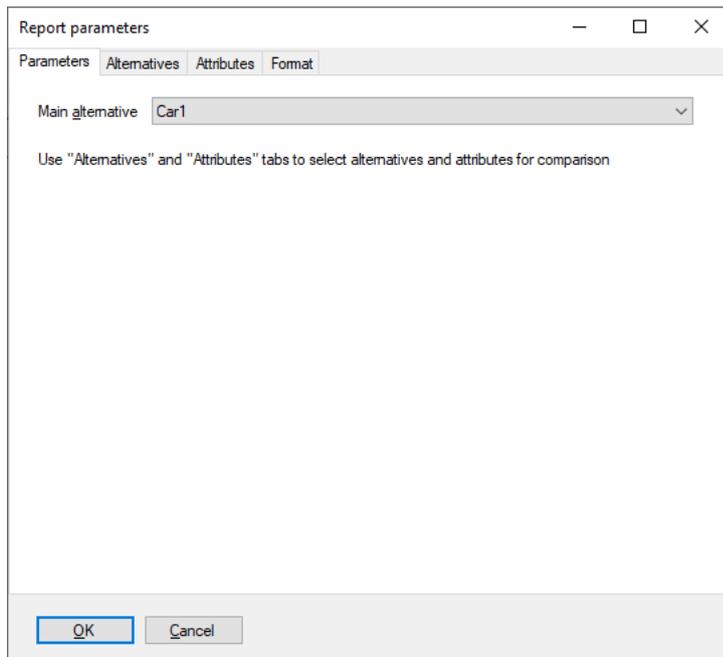
Plus/minus analysis: Results of plus/minus analysis: investigating the effects of changing one attribute at a time. *Report parameters* allow the selection of: the root attribute, considered alternative, maximum value steps in both directions, and the list of considered attributes.



Target analysis: Results of target analysis: try to improve/degrade an alternative by changing multiple attributes. *Report parameters* allow the selection of: the goal attribute, considered alternatives, search direction (“improve” or “degrade”), the list of considered attributes, maximum number of value steps, whether or not the investigated changes are unidirectional, and the maximum number of generated and displayed solutions.



Compare alternatives: Compare evaluation results of some alternative with others. *Report parameters* allow the selection of the main alternative, and the lists of other alternatives and attributes to be considered in comparison.



6.2.11 Chart Report Elements

A chart report element can be created from the *Charts Page*. There, the graphic image of the currently displayed chart can be added to the main report on the *Report Page*.

6.2.12 Report Parameters

Report parameters is a dialogue window aimed at defining and editing properties of DEXiWin *reports*. It generally consists of four pages (tabs), called:

- *Parameters*
- *Attributes*
- *Alternatives*
- *Format*

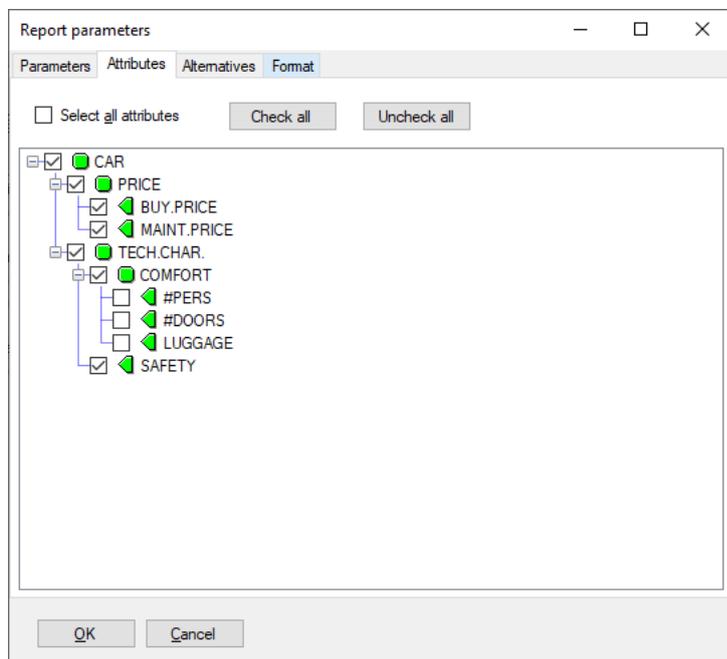
The *Attributes* and *Alternatives* pages are not shown when associated with report elements whose contents does not depend on the selection of attributes and alternatives, respectively.

Parameters Page

This is normally the first page shown in *Report parameters*. This page contains settings associated with a particular report element and is thus different for each element type. Please see *report elements* for examples of *Parameters* settings.

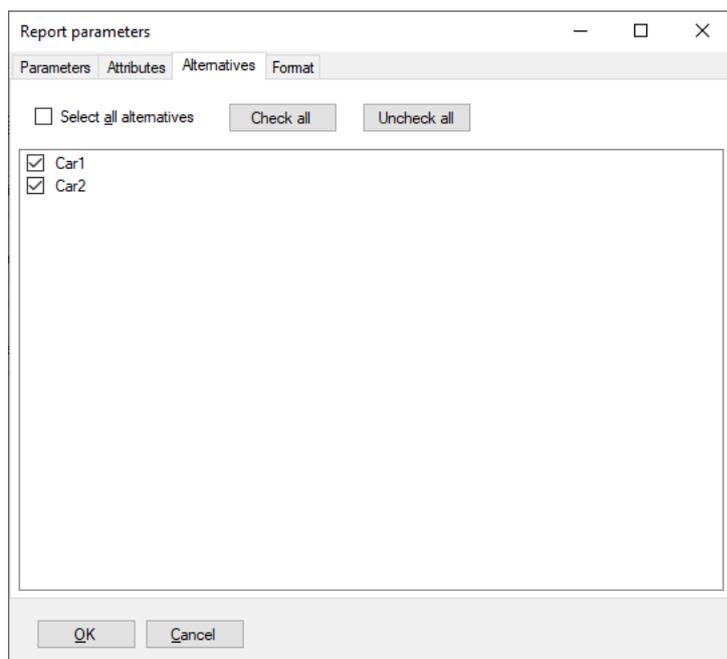
Attributes Page

The *Attributes Page* of *Report Parameters* is aimed at the selection of attributes to be considered in the report element. By default, all attributes are included. After unselecting “Select all attributes”, it is possible to select individual attributes, as shown below. There are also two buttons that select and unselect all attributes.



Alternatives Page

The *Alternatives Page* of *Report Parameters* is aimed at the selection of alternatives to be considered in the report element. By default, all alternatives are included. After unselecting “Select all alternatives”, it is possible to select individual alternatives from the list, as shown below. There are also two buttons that select and unselect all alternatives.



Format Page

Format Page is shown for all report elements and allows to define:

- **Report title** to be displayed in various report lists.
- The number of **Decimal places** to be used for displaying:
 - **General** floating-point numbers other than the ones listed below and other than values of continuous attributes, for which the number of decimals is defined together with corresponding *continuous scales*.
 - **Weights**, displayed in reports such as *Weight Tree* and *Functions*.
 - **Function definition** for numbers displayed in status bars and function summary reports, such as Rules: 12/12 (100,00%), determined: 100,00% [unacc:6,acc:1,good:2,exc:3].
 - **Distributions** for membership numbers displayed in value distributions, such as medium/0.60;high/0.40.

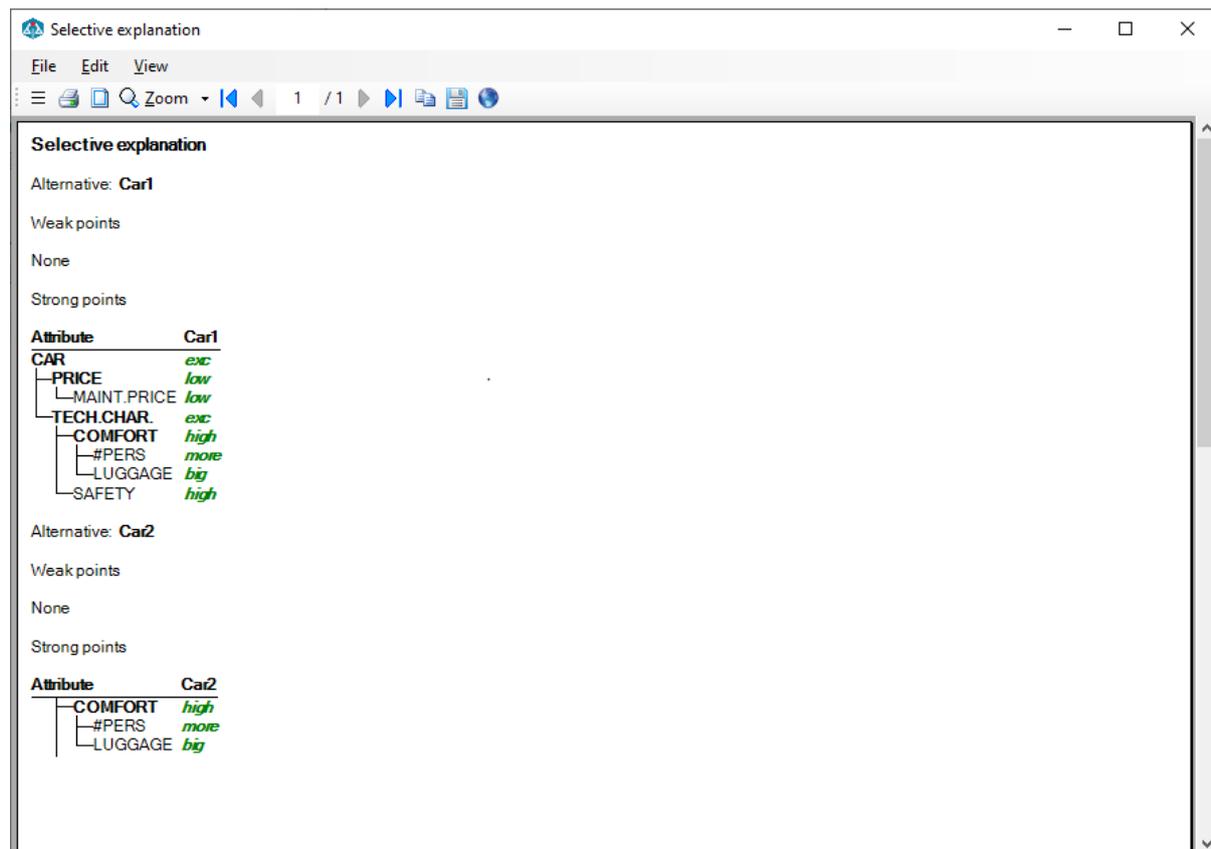
In all cases, valid range for the number of decimal places is from -1 to 10. The values from 0 to 10 define a fixed number of decimals for any number, while -1 depends on the particular number to be displayed and denotes any number of decimals suitable to fully represent that value.

The screenshot shows a dialog box titled "Report parameters" with four tabs: "Parameters", "Attributes", "Alternatives", and "Format". The "Format" tab is active. It contains a text field for "Report title" with the value "Evaluation results". Below this is a section titled "Decimal places for displaying numbers" with four spinners: "General number" set to 4, "Weights" set to 0, "Function definition" set to 2, and "Distributions" set to 2. At the bottom of the dialog are "OK" and "Cancel" buttons.

6.2.13 Preview Window

Preview is a DEXiWin window for displaying a single *report element* independently of *report pages*, which are shown as part of the *Model Window*. *Preview* displays reports using the document format and can be activated from:

- *Aggregation Function Editor*
- *Evaluation Page*



Commands

Preview provides menu commands and toolbar buttons similar to those of the *Report Page* while using the document format.

 **File/Save report...**: Saves complete contents of the current report on one or more files, offering a choice between four formats: HTML, Text, Bitmaps, and Metafiles. The former two formats save the report on one file, while the latter two formats write series of one or more consecutively numbered graphic files, each holding one report page.

 **File/Print...**: Prints the current report.

 **File/Page setup...**: Opens a *Page Setup* dialogue in which you can define paper size used for printing, portrait or landscape orientation, and four page margins: left, right, top, and bottom.

 **Edit/Report parameters...**: Opens *Report Parameters* window for defining the properties of the currently shown report element.

Edit/Add report: Add the currently displayed report element to the main report, located on the *Report Page*.

 **Edit/Copy report page...**: Copies the currently displayed report page to the clipboard, in one of the following ways:

 **Copy as metafile**: Using the metafile graphic format.

 **Copy as bitmap**: Using the bitmap graphic format.

Crop as metafile and **Crop as bitmap**: These commands copy only graphic contents, while removing all bordering white space; this is useful for creating graphics to be inserted in other documents.

 **View/Zoom...**: Adjusts the zoom level of the document. In addition to some predefined zoom percentages (from 5% to 500%), standard zoom levels can be selected:

-  Actual size
-  Show full page
-  Show full page width
-  Show two pages side by side

 **Open report in browser**: Shows the current report in the *internal* or system browser, depending on *settings*.

The following toolbar buttons are provided for **navigation** between report pages:

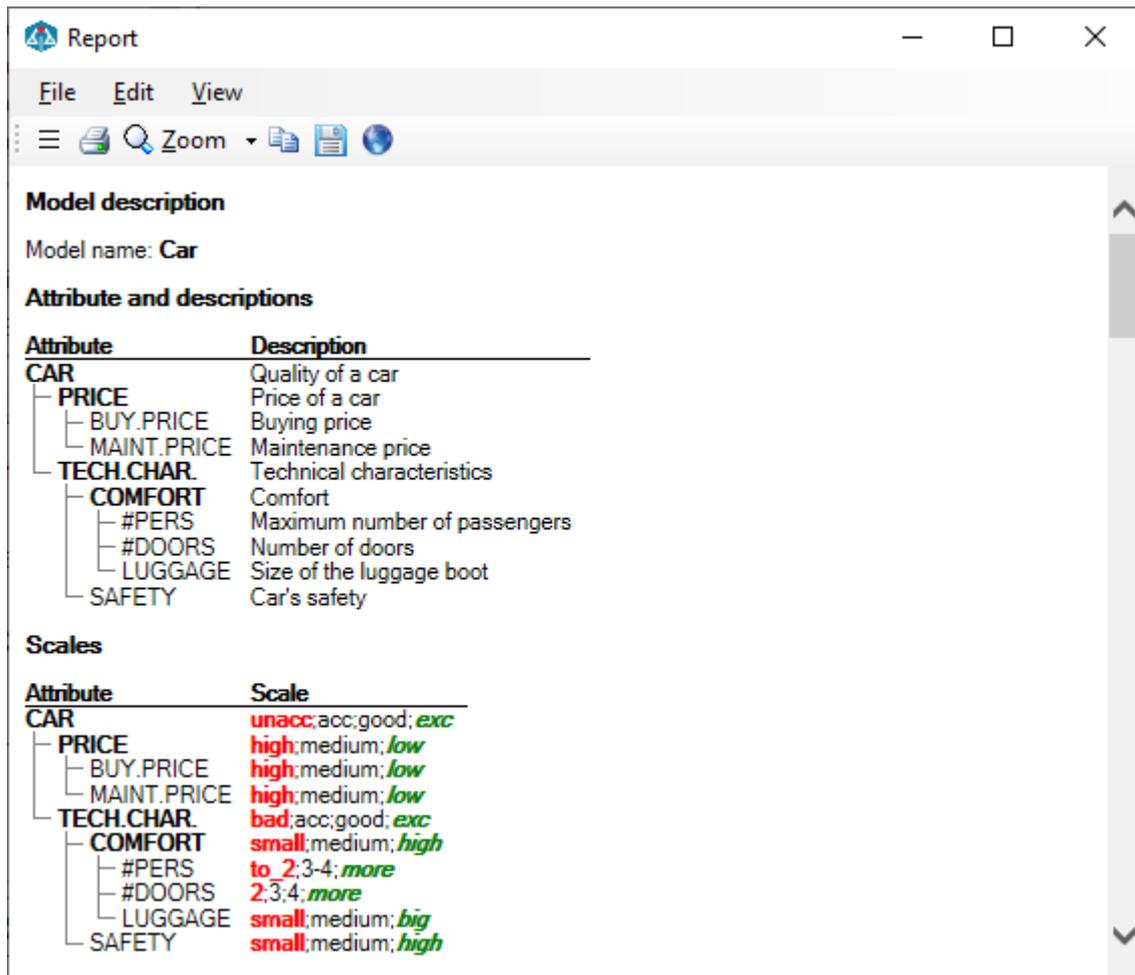
-  Go to the first page
-  Go to the previous page
-  Go to the next page
-  Go to the last page

To go directly to some page, type the page number in the edit box located on the toolbar.

6.2.14 Internal Browser

Internal Browser is a DEXiWin window for displaying a *report* independently of *report pages*, which are shown as part of the *Model Window*. *Internal Browser* displays reports using the HTML format and can be activated from:

- *Report Page*
- *Preview*
- *Aggregation Function Editor*
- *Evaluation Page*



Commands

Internal Browser provides menu commands and toolbar buttons similar to those of *Report Page* while using the HTML format.

 **File/Save report...**: Saves complete contents of the current report on a file, using the HTML format.

 **File/Print preview...**: Opens a HTML print preview form, which allows some adjustments of the page, possibly followed by printing the document.

File/Print...: Prints the current report.

 **Edit/Report parameters...**: Depending on whether the browser currently displays a single or multiple report elements, this commands opens:

- Single element: *Report Parameters*, a window for defining properties of the element;
- Multiple elements: *Report Manager*, a window for adding, editing and deleting report elements.

 **View/Zoom...**: Adjusts the zoom level of the document. Three options are possible:

- Zoom in
- Zoom out
- Reset to the original zoom level

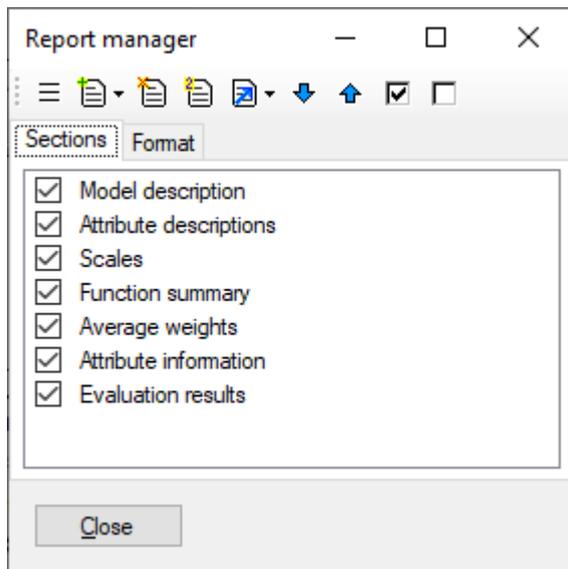
 **Open report in system browser**: Shows the current report in the system browser.

6.2.15 Report Manager

Report Manager is aimed at managing DEXiWin *reports* that contain multiple *report elements*. Those elements can be:

- individually selected and deselected for displaying in the report,
- added to the report,
- deleted from the report,
- duplicated,
- shown in a separate window, and
- copied or moved to other *Report Pages*.

Additionally, it is possible to change the order and individual settings of elements.



Workspace

Report Manager consists of two pages: *Elements* and *Format*.

Elements page displays a list of elements included in the report. Elements can be individually selected. Only selected elements are actually displayed in the report.

Double-clicking an item on the *Elements page* opens up the *Report Parameters* window, providing an opportunity to edit this element's properties.

Format page allows changing two settings that apply to the entire report: report title and font.

Commands

Commands, available as buttons on the toolbar and menu items on the right-click pop-up menu, are:

☰ **Report parameters:** Opens the *Report Parameters* window for editing the detailed settings of the currently selected report element.

📄 **Add report element:** A drop-down button providing a list of all available *report elements*. After an element has been selected, it is added to the *Elements* list using the default settings, which can be modified later.

🗑️ **Delete report element:** Delete the currently selected element from the list.

 **Duplicate report element:** Duplicate the currently selected element and place the copy just after it in the list.

 **Show, copy or move report element:** This drop-down menu button provides three items:

- **Show in a window:** Shows the currently selected element in a separate window, either in the *previewer* or browser (*internal* or system), depending on *settings*.
- **Copy to...:** Copies the currently selected element to another tab, either a new tab or one that already exists in the *Model Window*.
- **Move to...:** Moves the currently selected element to another tab, either a new tab or one that already exists in the *Model Window*.

 **Move down:** Move the currently selected element one position down in the list.

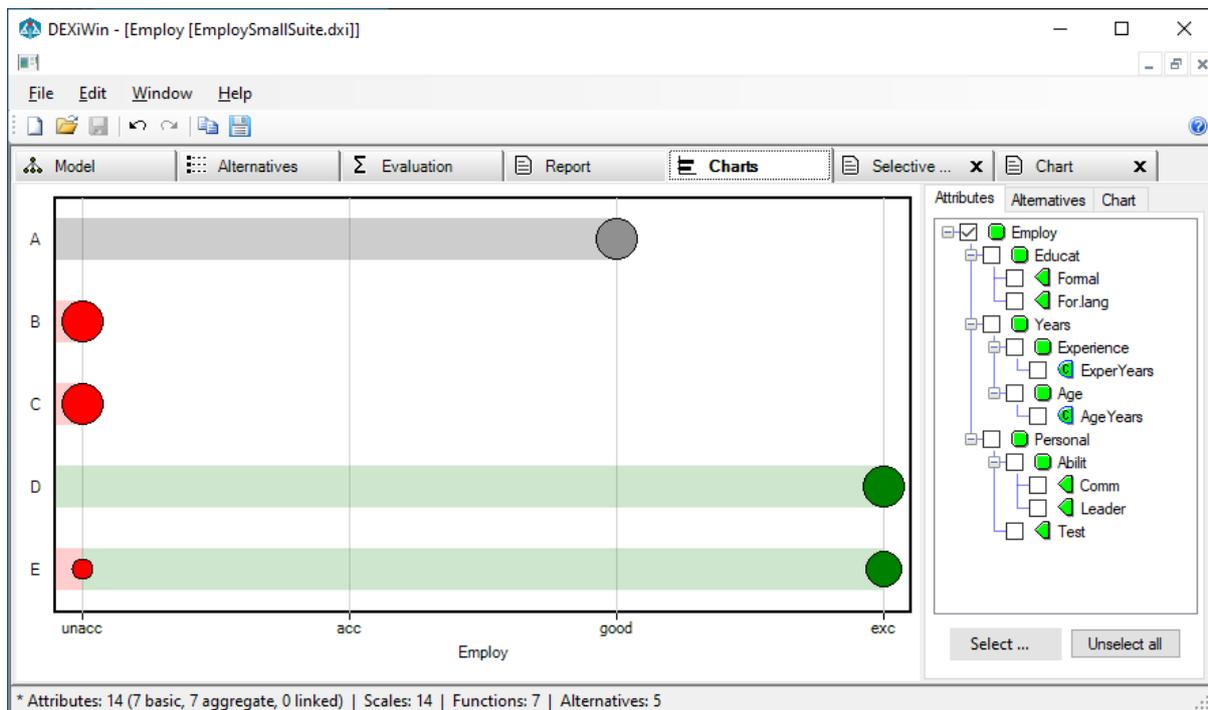
 **Move up:** Move the currently selected element one position up in the list.

Select all report elements: Check all elements in the list.

Unselect all report elements: Uncheck all elements in the list.

CHARTS PAGE

DEXiWin's *Chart Page* is used to compose and display charts that show *evaluation results*, one chart at a time. Chart graphics can be copied to the *main report*.



Workspace

The workspace consists of a *chart display* on the left and *control area* on the right. The latter consists of three tabs:

- *Attributes*: For selecting attributes to be displayed.
- *Alternatives*: For selecting alternatives to be displayed.
- *Chart*: Settings to control chart contents and format.

Commands

To invoke a command, you may either select an item from the main menus, toolbar or right-click and select an item from the pop-up menu.

 **File/Save chart... **:** Opens a dialogue to save the current chart on a file, using the metafile (.emf) or bitmap (.png) format.

Edit/Add to Report: Adds the current chart as a graphic to the main report on the *Model Window*.

 **Edit/Copy as metafile...:** Copies the current chart to the clipboard in metafile format.

 **Edit/Copy as bitmap...:** Copies the current chart to the clipboard in bitmap format.

7.1 Attributes Page

The selection of attributes is particularly important, because it largely determines the chart type shown:

- No selected attributes: No chart is displayed
- One selected attribute: Bar chart is displayed
- Two selected attributes: Scatter chart is displayed
- Three or more selected attributes: One of the following chart variations is displayed:
 - Radar chart: Displaying all alternatives on a single chart
 - Radar grid: Displaying multiple radar charts, one alternative per chart
 - Linear chart: Displaying alternatives' value profiles

In addition to selecting individual attributes in the tree, there are two buttons:

- **Select ...:** A drop-down button providing menu items to select: all attributes, basic attributes, root attribute(s) and attributes positioned on the first, second or third level of the tree.
- **Unselect all:** Unselect all attributes.

See *examples of charts* below.

7.2 Alternatives Page

Similarly as for attributes, this page allows selecting and deselecting individual alternatives for display. There are two buttons: to **Select all** or **Unselect all** alternatives.

7.3 Chart Page

This page provides various settings to control chart contents and format of its components.

The topmost control called *Chart type for >2 attributes* is essential. It provides three chart-type options that apply in the case when more than two attributes are selected: *Radar*, *Radar grid*, and *Linear*. For *Radar grid* charts, it provides controls to define horizontal and vertical grid dimensions.

The screenshot shows the 'Chart' tab of the software interface. It contains the following settings:

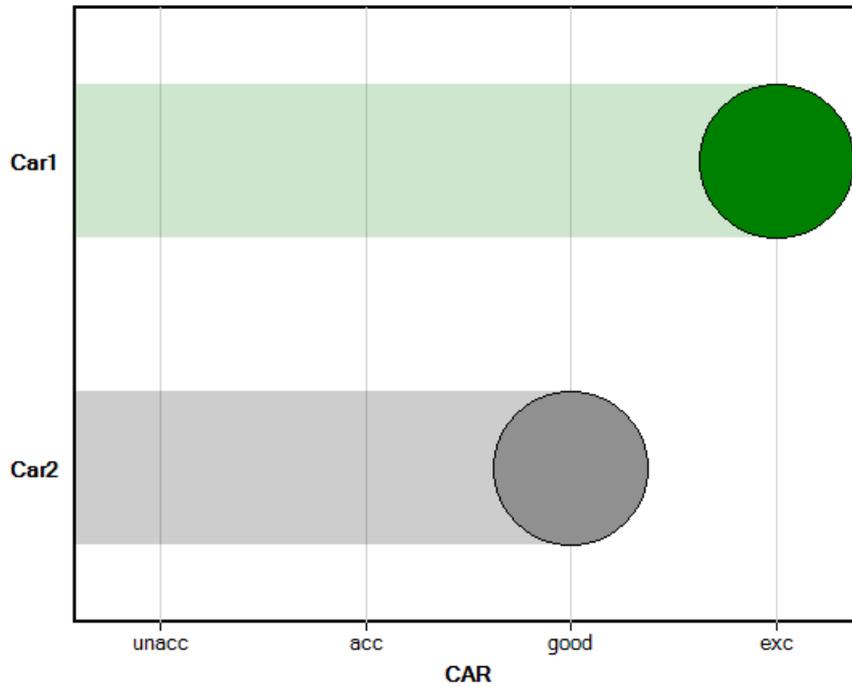
- Chart type for >2 attributes:** Radar Grid
- Grid:** 2 x 1
- Chart borders:** Four spinners, all set to 10.
- Sizes:**
 - Text gaps: 5
 - Line width: 2
 - Bar width [%]: 50
 - Point sizes: Scatter (10), Radar (3), Linear (5)
- Colors:**
 - Transparency [%]: 80
 - Buttons: Background ..., Chart area ...
- Fonts:**
 - Buttons: Alternatives..., Attributes..., Values...

The remaining controls on the *Chart Page* can be used to set up:

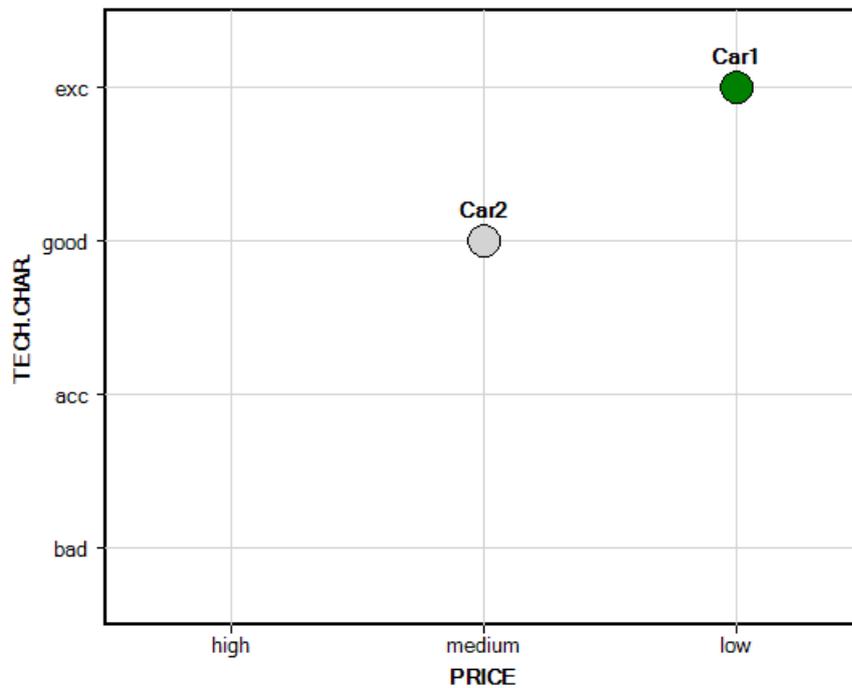
- All four *Chart borders*, in pixels
- *Sizes* of gaps between text items [pixels], line widths [pixels], bar widths [%] and points shown in the scatter, radar and linear charts [pixels]
- Chart *Colors* and *Fonts*

7.4 Examples of Chart Types

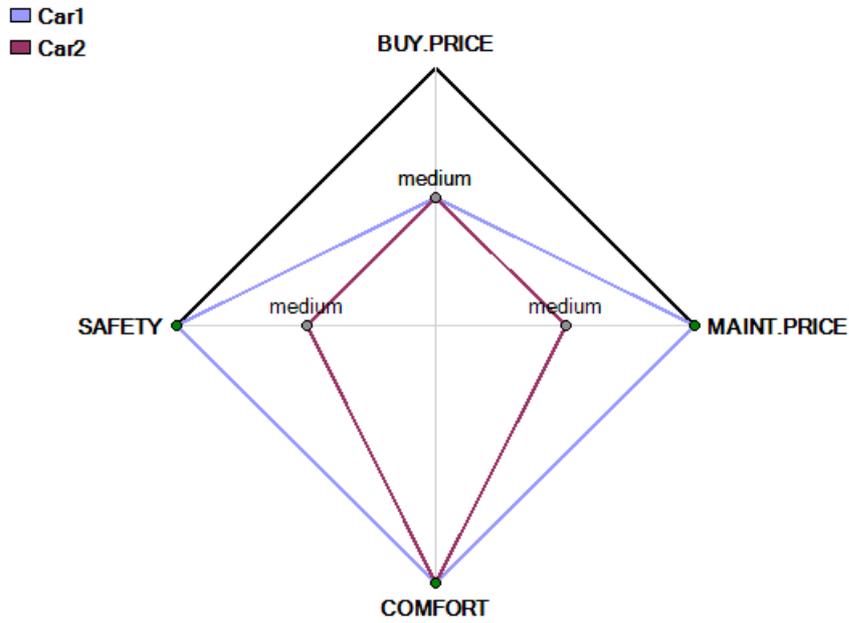
7.4.1 Bar Chart (one attribute selected)



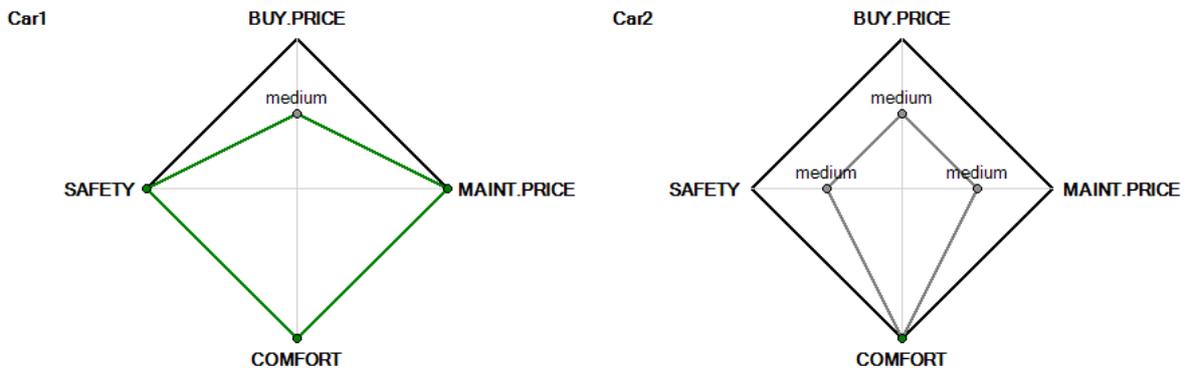
7.4.2 Scatter Chart (two attributes selected)



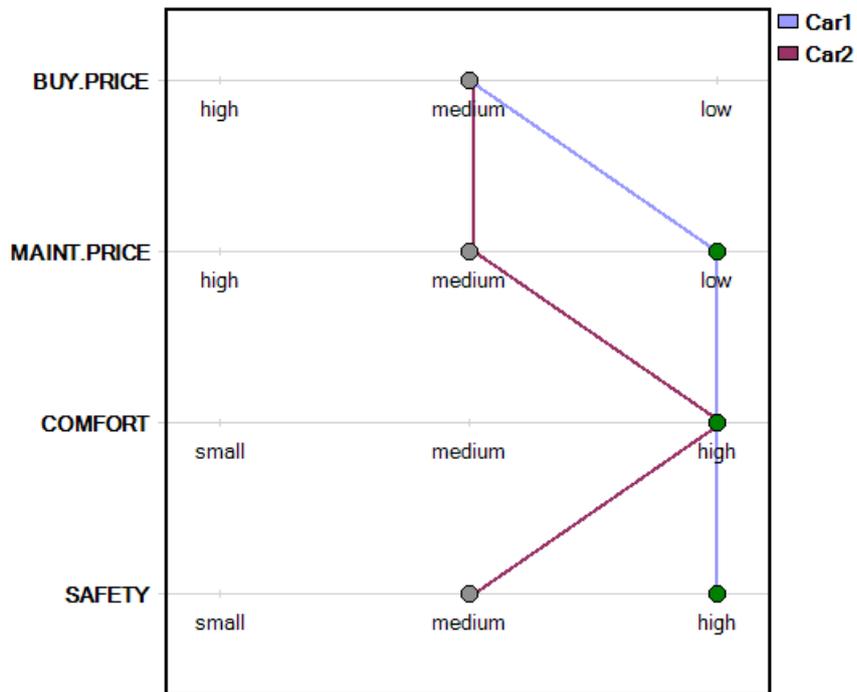
7.4.3 Radar Chart (three or more attributes selected)



7.4.4 Radar Grid Chart (three or more attributes selected)



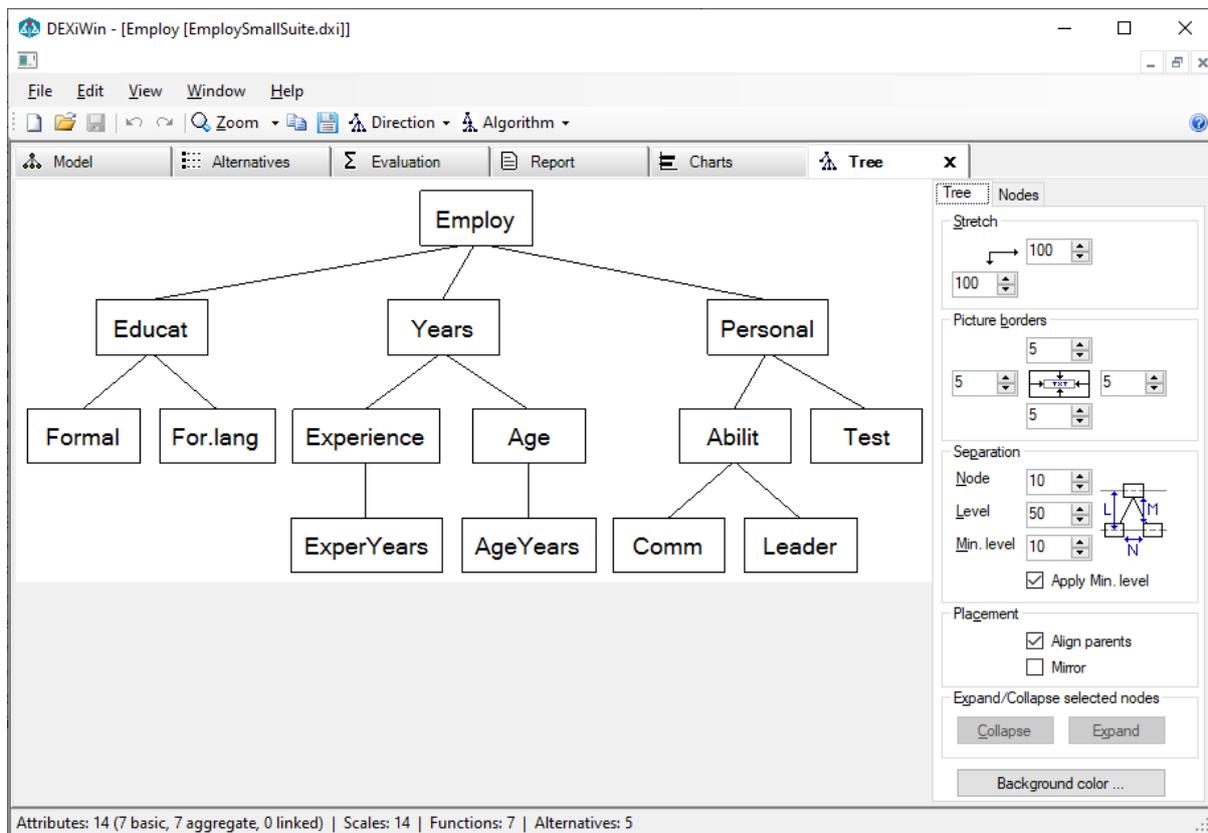
7.4.5 Linear Chart (three or more attributes selected)



TREE VIEW

Tree View is a temporary page located on the *Model Window* for making and view drawings of *DEXi Models* tree structure. This page can be created by **View/Tree graphic...** command while located on the *Model Page*. At most one *Tree View* page is allowed. On this page, you can:

- Interactively design a drawing of tree structure by
 - choosing between four tree-drawing algorithms,
 - selecting the drawing direction, and
 - modifying an extensive set of drawing parameters.
- Save the drawing to a file, or copy the drawing to clipboard for transferring to other applications. Two graphic formats are supported:
 - Windows Enhanced Metafile (.emf): a vector graphic format,
 - Bitmap (.png): a bitmap graphic format.



Workspace

The workspace consists of a *drawing display* on the left and *control area* on the right. The latter consists of two tabs for controlling the display of *Tree* elements and individual *Nodes*. The latter contains two additional tabs, *Graphic* and *Text*.

It is possible to choose one or more tree nodes on the drawing:

- Mouse click: Selects the clicked node and deselects all others.
- Ctrl + Click: Selects or deselects the clicked node.

Selected nodes are indicated by a blue rectangle, drawn around them.

Commands

Tree View commands are available from the *File*, *Edit* and *View* menus, on the toolbar and from the pop-up menu that appears after right-clicking the mouse in the drawing area.

File/Save tree...: The current drawing can be saved on a file using one of the mentioned formats: metafile or bitmap.

 **Edit/Copy as metafile...**: Copy the current drawing to the clipboard using the metafile format.

 **Edit/Copy as bitmap...**: Copy the current graphic to the clipboard using the bitmap format.

 **View/Zoom...**: Adjusts the zoom level of the drawing. In addition to some predefined zoom percentages (from 5% to 500%), standard zoom levels can be selected:

-  Actual size
-  Show full drawing on the page
-  Expand the drawing to cover full page width

Direction: *Tree View* can draw trees in four different directions:

-  *Top-Down*,
-  *Left-Right*,
-  *Bottom-Up*, and
-  *Right-Left*.

The Top-Down direction places the root of the tree at the top of the drawing and branches the tree downwards. The other three directions in turn correspond to 90-degree counter-clockwise rotations of the tree structure. Displayed text is never rotated.

Algorithm: *Tree View* uses four different node-positioning algorithms:

-  *Distribute*: For Top-Down and Bottom-Up drawings, this algorithm horizontally distributes leaves of the tree so that each leaf occupies its own vertical range. This algorithm works especially well for Left-Right and Right-Left drawings, where each leaf occupies one “line” of the drawing.
-  *Align*: The same as *Distribute*, except that all leaves are aligned at the same (lowest) level of the drawing.
-  *Walker*: This is an implementation of the Walker’s algorithm, which is particularly suitable for Top-Down and Bottom-Up drawings. In principle, this algorithm tries to move sub-trees together as close as possible while maintaining some tree-drawing “aesthetic criteria”.
-  *QP*: This is our own version of a “stress-minimization” algorithm that positions tree nodes by solving a constrained quadratic minimization problem. Typically, this algorithm uses the available

drawing space very efficiently and makes pleasant drawings, while possibly violating some “aesthetic criteria”.

Tree View Settings

The tabs shown on the right side of *Tree View* contain numerous controls to affect the appearance of the tree and its components. Notice that the *Node* page has two sub-pages: *Graphic* and *Text*.

8.1 Tree Page

The *Tree Page* parameters affect the placement of the tree as a whole.

Stretch: Percentage of additional horizontal and vertical stretching of the drawing.

Picture borders: Additional pixels added at each side of the drawing.

Separation: [all units are in pixels]

- **Node:** Separation of two adjacent nodes. More precisely: horizontal separation for Top-Down and Bottom-Up drawings, and vertical separation for Left-Right and Right-Left drawings.
- **Level:** Separation of two adjacent levels.
- **Min. level:** Minimum distance between two node boxes that appear at adjacent levels. This applies when node boxes become too large (e.g., due to displayed text) to fit between the *Levels*.
- **Apply Min. level:** Check to activate the *Min. level*.

Placement:

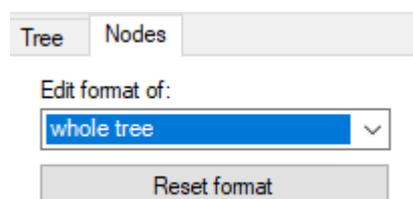
- **Align parents:** When checked, each parent is placed centrally above all of its descendants in the tree. Otherwise, it is centered only above its immediate descendants (“children”). *Align parents* does not work with the “QP” algorithm.
- **Mirror:** Mirrors the whole tree. This is especially useful for Left-Right drawings so that the leaves appear in the “logical” top-down order.

Background color: This button activates a dialog for selecting the background color of the whole drawing.

Expand/collapse selected nodes: Two buttons, *Collapse* and *Expand* are enabled when one or more nodes are selected in the drawing. Pressing the buttons collapses or expands the selected subtrees, respectively. In this way, you can trim off some subtrees and show just a portion of the whole tree.

8.2 Node Page

The *Node Page* controls the display of tree nodes. It has two sub-pages: *Graphic* and *Text*.



At the top of the *Node Page*, you can select the class of nodes or a specific node to which tree-drawing controls, displayed on sub-pages below, apply. The available node classes are:

- selected nodes(s)
- whole tree
- aggregate attributes
- basic attributes
- discrete inputs: basic attributes associated with qualitative scales
- continuous inputs: basic attributes associated with continuous scales
- linked attributes
- root attributes
- collapsed nodes

Reset format: This button resets the format of the selected category of nodes to default values.

8.3 Node/Graphic Page

This sub-page defines graphical properties for displaying the selected category of tree nodes.

The image shows a software dialog box with two tabs: 'Graphic' and 'Text'. The 'Graphic' tab is active. It contains several sections:

- Dimensions:** A table with 'min' and 'max' columns. 'Width' has values 50 and 150; 'Height' has values 10 and 30. Each value is in a small box with up/down arrows.
- Node graphic:** A small rectangle with a vertical line extending upwards from its top center. To its right is a button labeled 'Edit ...'.
- Node alignment:** Three radio buttons labeled 'top', 'middle', and 'bottom'. The 'middle' radio button is selected.
- Top anchor:** Two rows. 'Horizontal' has a value of 50 and a dropdown menu showing '%'. 'Vertical' has a value of 0 and a dropdown menu showing '%'. Each value is in a small box with up/down arrows.
- Bottom anchor:** Two rows. 'Horizontal' has a value of 50 and a dropdown menu showing '%'. 'Vertical' has a value of 100 and a dropdown menu showing '%'. Each value is in a small box with up/down arrows.

Dimensions: Sets the minimum and maximum dimensions of the node “box” [in pixels]. When the minimum and maximum are different, the actual “box” dimensions are determined according to the text displayed in the box.

Node graphics: Opens a dialogue for configuring the graphic display of nodes. The dialogue settings include:

- *Line:* Setting the style, width and color of node-connecting lines.
- *Shape:* Shape type for displaying the node: *Rectangle*, *Ellipse*, or *Rounded*. For *Rounded*, the radius of edges [in pixels] can be defined, too.
- *Border line:* Setting the style, width and color of node border lines.
- *Fill:* Setting the style, color and hatch pattern of node interior.

Node alignment: Refers to how are node “boxes” of different dimensions positioned at one tree level, that is, whether they are aligned at their top, middle or bottom positions.

Top anchor: Defines the originating point position for the line that connects nodes with their parents. These points are defined relative to the node “box” and can be expressed in terms of pixels or percentages.

Bottom anchor: Similar to “Top anchor”, except that it refers to lines that connect nodes with their descendants in the tree.

8.4 Node/Text Page

This sub-page defines properties of text displayed in the selected category of tree nodes.

The screenshot shows the 'Text' tab of a configuration window. It is divided into several sections:

- Text Borders:** Four spinners, each set to the value '5', representing top, bottom, left, and right margins.
- Format:**
 - Wrap
 - Clip
 - Trim to: 1 characters
 - Line space: 100 %
- Position:** A 3x3 grid of dots. The center dot is replaced by the text 'TEXT', indicating center alignment.
- Buttons:** 'Font ...' and 'Font color ...' buttons at the bottom.

Text borders: These controls define internal borders [in pixels] that separate displayed text from the surrounding node rectangle.

Format:

- **Wrap:** When checked, the text can be wrapped so as to fit in the node “box”.
- **Clip:** When checked, only the text within the “box” is displayed. Any text or its part that does not fit into the box is not displayed.
- **Trim to:** Here you can specify the maximum number of displayed characters. This is useful for trimming long node texts.
- **Line space:** For wrapped text, specify line spacing. 100% refers to single spacing.

Position: Provides nine clickable elements for specifying text position in the node “box”. Horizontally, the displayed text can be left-justified, centered or right-justified. Vertically, the text can top-aligned, centered or bottom-aligned.

Font ..: Choose font for displaying text in nodes.

Font color ...: Choose font color for displaying text in nodes.

8.4.1 Examples of Tree Views

This example illustrates the main *Tree View* drawing types, displaying the structure of Car Evaluation model.

Top-Down Orientation

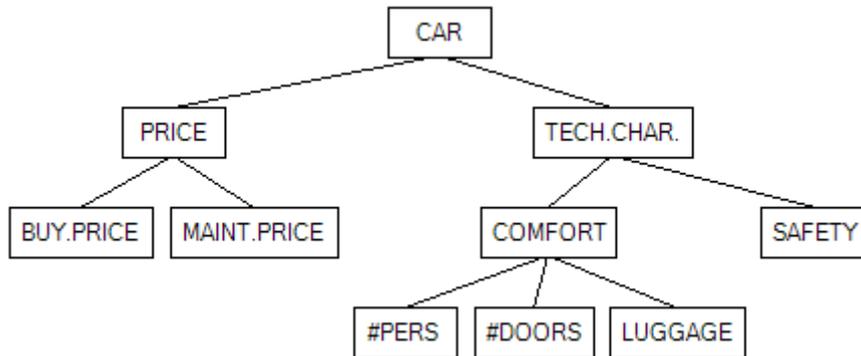


Fig. 1: Algorithm: Distribute

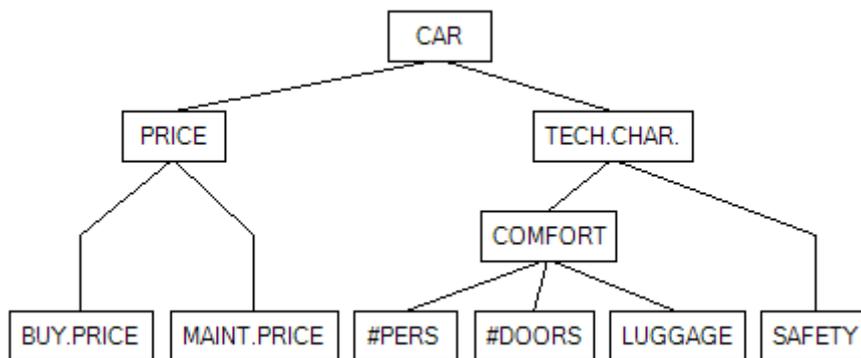


Fig. 2: Algorithm: Align

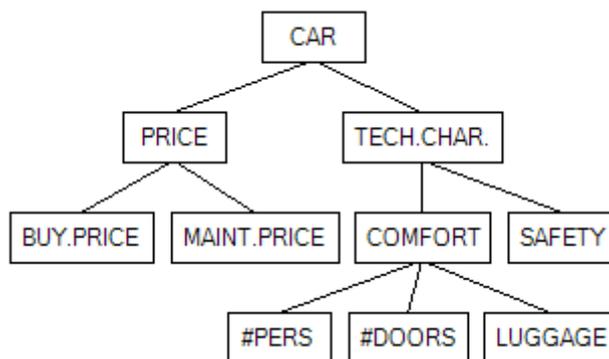


Fig. 3: Algorithm: Walker

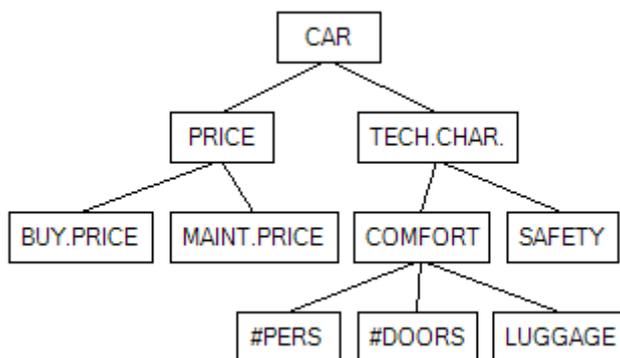


Fig. 4: Algorithm: QP

Left-Right Orientation

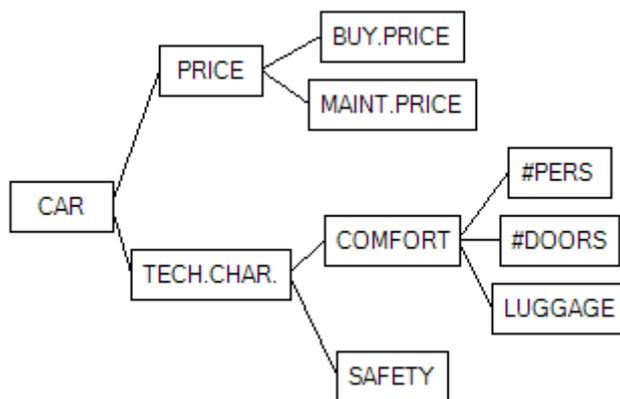


Fig. 5: Algorithm: Distribute

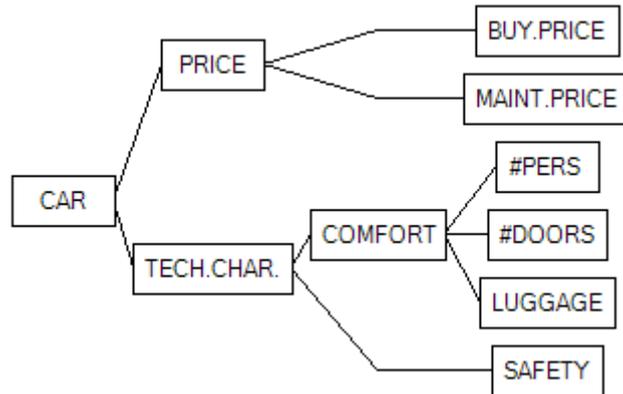


Fig. 6: Algorithm: Align

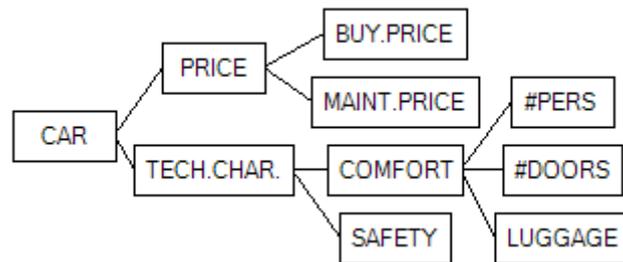


Fig. 7: Algorithm: Walker

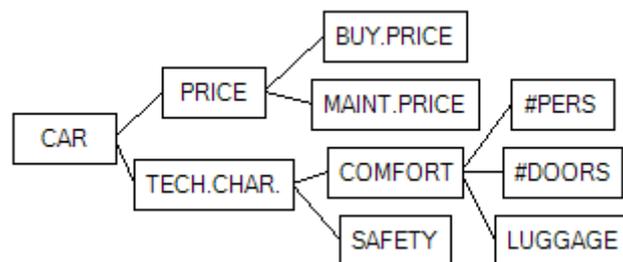


Fig. 8: Algorithm: QP

SETTINGS

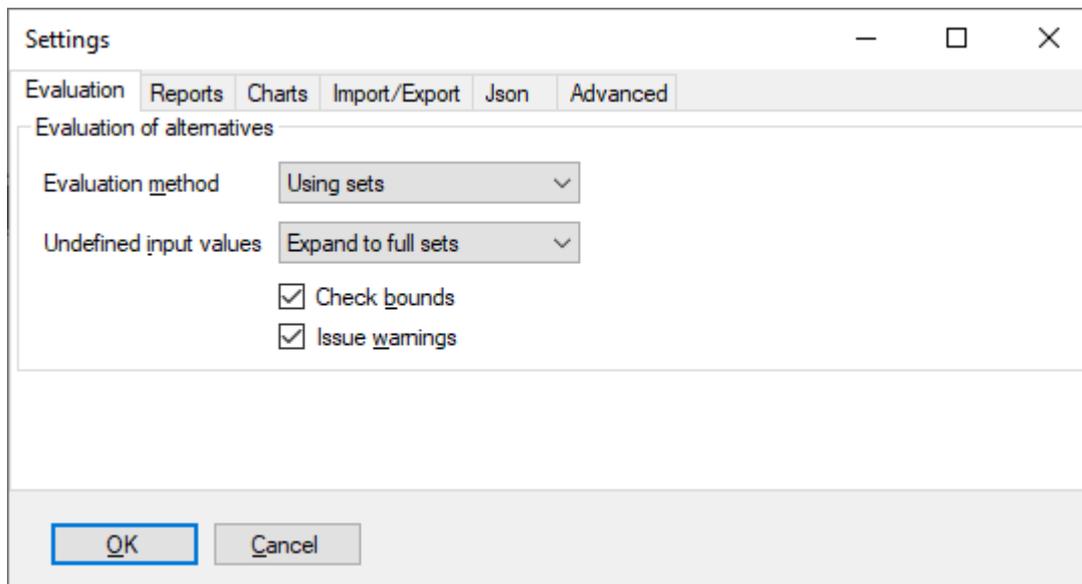
Settings is a window in which you can specify how DEXiWin handles particular aspects of the currently edited *DEXi model*. The dialogue consists of six pages:

- *Evaluation*: Configuring the alternative evaluation algorithm
- *Reports*: Configuring *reports*
- *Charts*: Configuring *charts*
- *ImportExport*: Configuring the format and contents of data about *functions* and *alternatives*
- *Json*: Configuring the format and contents of *Json files*
- *Advanced*: Advanced settings

Settings are bound to a particular DEXi model. Different models, even those simultaneously shown in the *Main Window*, may have different settings.

9.1 Evaluation Settings

This *Settings* page is aimed at configuring the alternatives' evaluation algorithm.



Evaluation method: Sets the *evaluation* method for all alternatives:

- Using sets
- Probabilistic
- Fuzzy

- *Fuzzy normalized*: As *Fuzzy*, with the addition that each fuzzy-distribution value is normalized after evaluation so that its maximum membership value equals 1.0.

Undefined input values: Defines handling of <undefined> values. There are two options:

- *Expand to full sets*: An <undefined> value or empty set are expanded to a full set * before evaluation.
- *Do not change*: Any <undefined> value, or an empty set, are left unchanged. Any evaluation involving an undefined value yields an undefined result. Any evaluation involving an empty set yields an empty set.

Check bounds: Whether or not evaluation results are verified to stay in the range prescribed by the corresponding attribute scales. In DEXiWin, out-of-range values are normally not expected and may indicate an error in the model definition.

Issue warnings: Whether or not the user is warned prior to model-editing operations that can considerably change (or even delete) model components (such as functions) and thus affect the evaluation procedure and results.

9.2 Reports Settings

This *Settings* page contains a number of settings that affect the display of *reports* and their components.

Font: Sets and Resets the main font used in reports.

Bad values and Good values: Define the fonts for displaying qualitative scale values that belong to ‘bad’ and ‘good’ categories, respectively.

Format: Defines various aspects of report formatting:

- **Show header:** Whether or not a header line is shown on report pages, viewed in the *Preview*. The header line includes: software name and version, date, and page number.
- **Tree display:** Provides options to display the leftmost column of *tree-structured report elements*:
 - *None*: Just indent attributes according to their level in the tree and do not use any other marks.
 - *Plus-Minus*: Use + and - characters to indicate tree structure.
 - *Indented dots*: Use . to indicate lines between tree nodes.

- *Full dots*: Use . to indicate tree levels.
- *Unicode*: Use Unicode characters |, |, ^l and – to draw lines between tree nodes.
- *Draw lines*: Draw lines between tree nodes graphically. This makes the most accurate display, but might fail on some devices, for instance while printing HTML documents.

Maximum number of columns for tree reports: Sets the maximum number of columns displayed on *tree-structured report elements* after the first column. Particularly suitable to limit the width of elements that display alternatives' evaluation results.

Decimal places for displaying numbers: Sets the number of decimal places to display:

- **General number:** All numbers other than the ones listed below and other than values of continuous attributes, for which the number of decimals is defined together with corresponding *continuous scales*.
- **Weights**, displayed in reports such as *Weight Tree* and *Functions*.
- **Distributions** for membership numbers displayed in value distributions, such as `medium/0.60; high/0.40`.
- **Function definition** for numbers displayed in status bars and function summary reports, such as `Rules: 12/12 (100,00%), determined: 100,00% [unacc:6,acc:1,good:2,exc:3]`.

In all cases, valid range for the number of decimal places is from -1 to 10. The values from 0 to 10 define a fixed number of decimals for any number, while -1 denotes any number of decimals necessary to fully represent some given value.

Displaying aggregation functions:

- *Representation*: Aggregation functions can be **displayed** using either *Elementary* or *Complex* rules, or *Decision trees*.
- The contents of these representations can be additionally detailed by the remaining check boxes, which specify whether or not:
 - to show rule numbers,
 - to show attribute weights,
 - to use normalized weights (instead of local weights),
 - to display only entered (defined) decision rules,
 - to show function status, including warnings about inconsistencies and other possible problems in function definitions,
 - to show *numeric values* associated with elementary rules (displayed only with *Elementary* representation),
 - to display numeric marginal values of qualitative input attributes' values.
- **Displaying weights:** Determines which columns are displayed in the *Weights tree* report element.

9.3 Charts Settings

This *Settings* page sets up default settings for displaying charts on the *Charts Page*. These settings can be changed on that page for individual charts.

Fonts: Defines or *Resets* fonts used to display alternative names, attribute names and values in charts.

Chart type for more than two selected attributes: Defines the default chart type to be displayed when three or more attributes are selected on the *Charts Page*. Three possible options are: *Radar*, *Radar grid*, and *Linear* (see *examples*). Additionally, horizontal and vertical grid dimensions can be defined for *Radar grid* charts.

Sizes: A number of self-explanatory controls for defining sizes of particular chart elements.

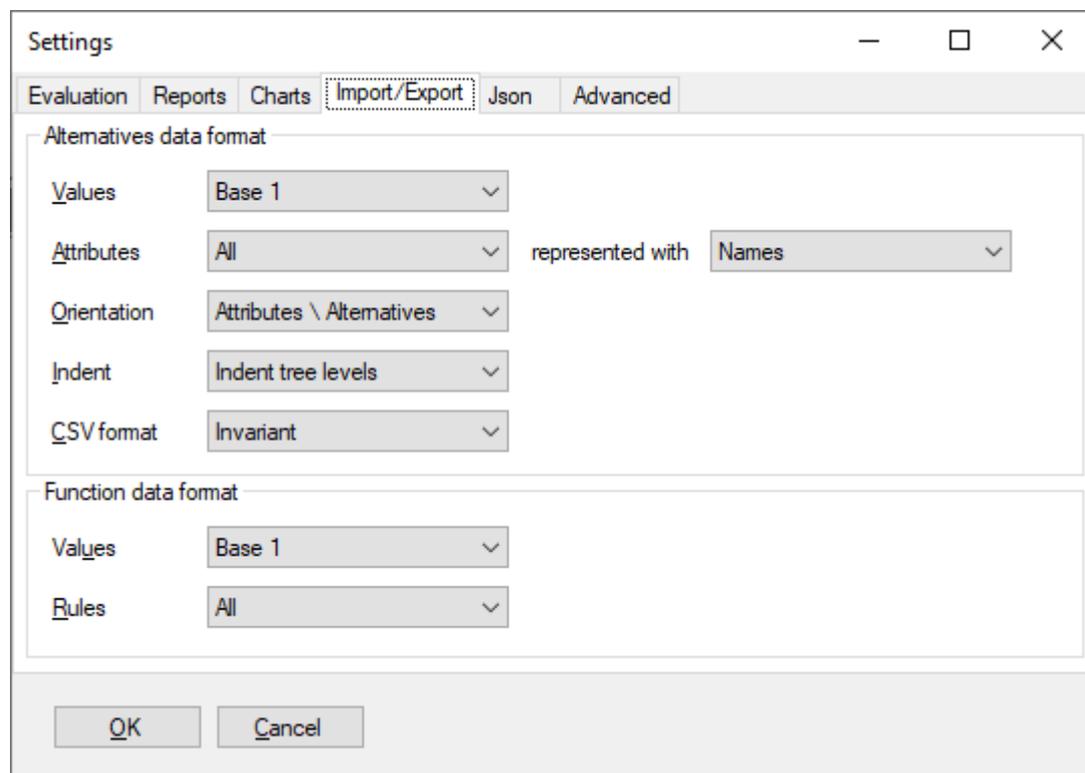
Default chart borders: Sets up all four chart borders: left, top, bottom, and right.

Colors: Buttons for setting up the colors of: chart background, chart area, and points corresponding to neutral-category or undefined values.

- **Transparency** refers to the transparency of shaded areas that are used in charts to display DEXi value sets or distributions.

9.4 Import/Export Settings

This *Settings* page controls the format and contents of the clipboard and files that store data about *functions* and *alternatives*.



Alternatives data format: These controls specify the format and contents of imported and exported *alternatives*.

- **Values:** Specifies the format of qualitative values, which can be either:
 - *Base 0*: Ordinal numbers starting at 0.
 - *Base 1*: Ordinal numbers starting at 1.
 - *Text*: Value strings, such as *good*.
 - *DEXi strings*: Strings formatted so as to unambiguously represent all DEXi value types.
- **Attributes:** Import/export the values of *All* or only *Basic* attributes.
- **Orientation:** Specifies whether table rows represent attributes (*Attributes \ Alternatives*) or alternatives (*Alternatives \ Attributes*).
- **Indent:** Specifies whether attribute names are indented or not. Indentation adds whitespace to outline the tree structure of attributes.
- **CSV format:** Specifies the format of comma-separated-value files, which can be either:
 - *Invariant*: Always uses the same characters to denote decimal points (.) and separate data items (,). Suitable for data sharing between different environments.
 - *Local*: Use localized decimal-point and separation characters, for instance, , and ;, respectively. These depend on your operating system settings. Suitable for transferring data to reports and other locally-produced documents.

Function data format: These controls specify the format and contents of imported and exported *functions*.

- **Values:** Specifies the format of qualitative values, which can be either:
 - *Base 0*: Ordinal numbers starting at 0

- *Base 1*: Ordinal numbers starting at 1
- *Text*: Value strings, such as good
- *Rules*: export *all* or only *entered* decision rules.

9.5 Json Settings

This *Settings* page controls the format and contents of exported *Json data files*. These can generally contain both a DEXi model and alternatives, and are formatted in a way that can be easily and unambiguously shared between different applications and environments.

The screenshot shows the 'Settings' dialog box with the 'Json' tab selected. The 'Json export' section contains the following settings:

- Structure:** Flat
- Values:** Text
- Include:** Model and Alternatives
- Model elements:**
 - Name
 - Description
 - Id
 - Path
 - Indices
 - Indent
 - Level
 - Type
 - Scale
 - Function
- Alternative elements:**
 - Name
 - Description
 - Id
 - Path
 - Indices
 - Indent
 - Level
 - Type
 - Value as string
 - Value as data
- Inputs:** List
- IDs:** IDs
- Attribute types:**
 - Basic
 - Aggregate
 - Linked
- Decimal places:**
 - Numbers: -1
 - Membership: -1
- Other options:**
 - Use DEXi strings
 - Value distribution as array
 - Indent Json output
 - Include time stamps

Structure of a Json file can be either

- *Flat*: All attributes are exported in a linear Json array. Each attribute object contains additional information to locate its position in the tree.
- *Nested*: File structure follows the tree structure of attributes. Each exported attribute contains an “Inputs” array of its immediate descendant attributes in the tree.
- **Values**: Specifies the format of qualitative values, which can be either:
 - *Base 0*: Ordinal numbers starting at 0.

- *Base 1*: Ordinal numbers starting at 1.
- *Text*: Value strings, such as *good*.

Include: Specifies what data to export: *Model*, *Alternatives*, or both

Attribute types: Specifies which attribute types to export: *Basic*, *Aggregate*, and/or *Linked*.

Model elements and **Alternative elements** provide a number of checkboxes for selecting data items to be exported with each attribute while exporting the model or its alternatives, respectively. The following elements are shared between both lists:

- *Name*: Attribute name
- *Description*: Attribute description
- *Id*: Unique attribute ID
- *Path*: Attribute name path, consisting of all attribute names from the root of the tree to that attribute, separated by /, for example: `CAR/PRICE/MAINT.PRICE`. Notice that attribute paths may be ambiguous in the case of multiple attributes with the same name associated with some aggregate attribute.
- *Indices*: Attribute identification using indices of their position with respect to their parents in the tree, separated by ;. Example: `0;0;1` represents the same attribute as above. This representation is unambiguous, but sensitive to changes of model structure.
- *Indent*: A tree-indentation string of the corresponding attribute. For `CAR/PRICE/MAINT.PRICE`, this string is `|+` (compare with an actual *tree display*).
- *Type*: Attribute type, one of: “basic”, “aggregate” or “link”.

Model elements contains two additional elements:

- *Scale*: Include each attribute’s scale, if defined.
- *Function*: Include each attribute’s function, if defined.

Alternative elements also contains two additional elements:

- *Value as string*: Attribute value formatted as a DEXi string (see above).
- *Value as data*: Attribute value. A structure of multiple Json elements is used to represent non-trivial DEXi values, such as sets and value distributions.

Inputs: Specifies how to represent input attributes of some given attributes for the two data categories defined above (model and alternatives). Possible options are:

- *None*: Do not export attribute’s descendants in the tree.
- *List*: Use a list (Json array) of attribute objects.
- *IDs*: Use a list of attribute IDs.

Use DEXi strings: Whether or not to use DEXi strings to display alternatives’ values.

Value distribution as an array: Whether or not to represent value distributions with floating-point arrays.

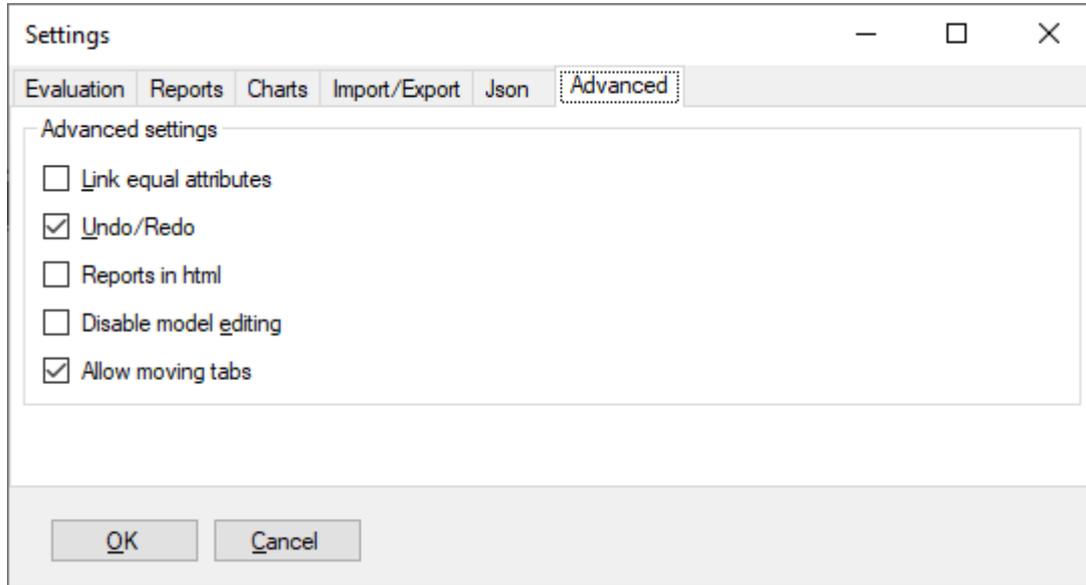
Indent Json output: Whether or not to “pretty-print” the data. Indenting considerably increases file size, but is human-readable. Non-indented Json files are suitable for data transfer.

Include time stamps: Whether or not to include data creation stamps in the file.

Decimal places: Decimal places for displaying general *numbers* and *membership* values in Json files. The default -1 takes as many places as necessary for each value.

9.6 Advanced Settings

This *Settings* page controls advanced aspects of DEXi model creation, editing and reporting.



Link equal attributes: Whether or not to employ *attribute linking*. When checked, DEXiWin tries to link attributes that have equal names and scales after each modification of the model. It is recommended to turn linking temporarily off during extensive editing, particularly with large models.

Undo/Redo: Activate or deactivate the Undo/Redo functionality when editing models and alternatives.

Reports in html: When not checked, reports are shown on the *Report Page* or in *Preview Window* using the “document” format. Otherwise, reports are shown in the HTML format. When *Reports in html* is checked, another checkbox *Use default system browser* appears, allowing to switch between the *internal* or system browser.

Disable model editing: Specifies whether or not it is possible to edit the model on the *Model Page*. When checked, all model editing commands are suppressed. It is possible to open *Function Editor* to view functions, but saving changes is disabled. Editing of alternatives is unaffected by this control. Disabling model editing is useful to prevent unintentional changes after the model has been completed.

Allow moving tabs: Specifies whether or not pages on the *Model Page* can be reordered by moving them left and right using the mouse.

SOFTWARE VERSIONS

10.1 Version 1.0

Released: 2023-10-03

Initial version.

10.2 Version 1.1

Released: 2024-02-29

- New functionality:
 - Added predefined scales
 - Decision rules: Added representation using decision trees
 - Reports: Added Model Statistics report
 - Comparison of alternatives: Added comparison operators (“Deep Compare”)
 - Tabular function chart: Added Advanced tab for displaying numeric overlays
 - Tabular function display: Elementary rules: Added numeric evaluations of decision rules
- Bug and stability fixes

10.3 Version 1.2

Released: 2024-07-02

- New functionality:
 - Decision tables: Added symmetricity checking and setting features
 - Decision tables: Added calculation of input attributes’ marginal values
 - Alternatives: Editing the order of input attributes
 - Added Qualitative-Quantitative (QQ) evaluation of alternatives
 - Reports: Cropping report pages and individual elements
 - Tabular Functions: Remembering display settings for the duration of the session
 - Charts: Reordering displayed alternatives and choosing the first alternative displayed on a Radar Grid
- Bug and stability fixes