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Software

M-MACBETH version 1.1

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NEWS: The M-MACBETH team is pleased to announce the new version of the M-MACBETH software, released in July 2005. The new version is available in four different languages: English, French, Portuguese and Spanish.

M-MACBETH is a multi-criteria decision support software that permits the structuring of value trees, the construction of criteria descriptors, the scoring of options in relation to criteria, the development of value functions, the weighting of criteria, and extensive sensitivity and robustness analysis about the relative and intrinsic value of options.

The M-MACBETH software is based on the implementation of the MACBETH methodology (**M**easuring **A**ttractiveness through a **C**ategorical **B**ased **E**valuation **Tech**nique). An important distinction between MACBETH and many other Multiple Criteria Decision Analysis methods is that MACBETH requires only qualitative judgements about the difference of attractiveness between two elements at a time, in order to help a decision maker, or a decision-adviser group, to generate numerical scores for the options in each criterion and to weight the criteria. The MACBETH approach is based on the additive value model and aims to support interactive learning about the evaluation problem and the elaboration of recommendations to prioritize and select options in individual or group decision making processes.

The **M-MACBETH** software allows model structuring through a representation module where the points of view are commonly organized in a tree structure, usually referred to as a "value tree". The "value tree" (see figure 1) provides a useful visual interface of the structure of the points of view in several levels of increasing specificity.

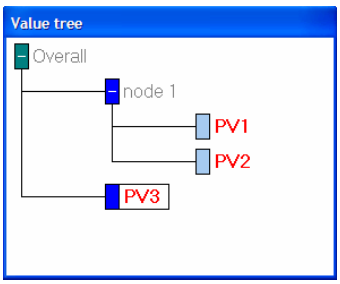

Figure 1 – Value tree.

The structuring component of the M-MACBETH software was designed with the purpose of being flexible enough to welcome all sorts of value trees, so that each time a point of view is inserted in the tree, the user can specify if it is a decision criterion or a simple node on the tree.

The name "**MACBETH** approach**"** comes from the mode of questioning. The process of building preferences requires that cardinal information concerning the attractiveness of the elements of a finite set be obtained from decision makers. The transition from ordinal to cardinal information reveals the origin of the notion of strength of preference, which in the MACBETH approach is designated as "difference of attractiveness". The questioning procedure involves verbal information about the difference of attractiveness between two elements at a time, on the basis of the following seven semantic categories: "no", "very weak", "weak", "moderate", "strong", "very strong", and "extreme" difference of attractiveness. Judgemental hesitation or disagreement can be handled using several consecutive semantic categories.

For each of the answers about a new pair of elements, the software tests the compatibility of the information collected with regard to cardinal information. When incompatible judgments are detected, the software gives a warning message ("inconsistent judgements") and the discussion with the decision maker can begin. To facilitate such a discussion, the software allows the source of the

problem to be graphically displayed and provides suggestions to overcome inconsistencies. Once the incompatibility has been solved, the M-MACBETH software can propose a numerical scale, upon demand and at any moment (i.e. it is not necessary to make all pairwise comparisons). The software presents a graphic representation of the proposed scale and friendly tools that allow its progressive transformation into a cardinal scale (see figure 2).

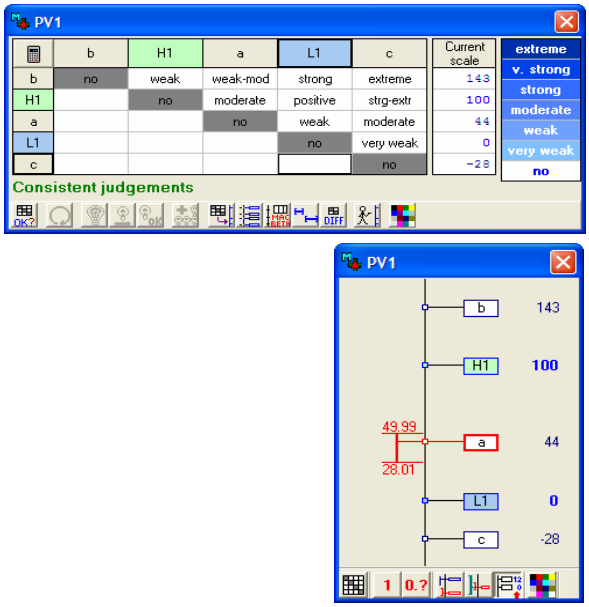

Figure 2 – Numerical and graphical display of a precardinal scale.

The M-MACBETH software also has a module that aggregates the scoring and weighting scales in an overall scale of attractiveness. Criteria weights can be represented in a bar chart (see figure 3)

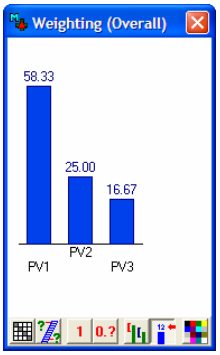

Figure 3 – Criteria weights.

The overall attractiveness of options is obtained through an additive aggregation model. The software presents the summarized information within a Table of scores (see figure 4), and proposes a graphic representation, the Overall thermometer, useful for discussion and analysis in group decision making settings.

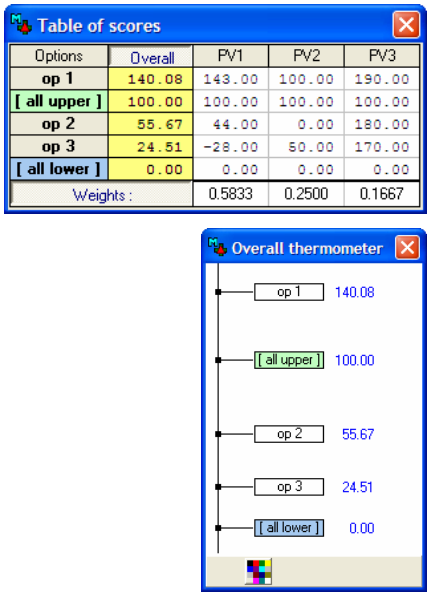

Figure 4 – Table of scores and overall thermometer.

The M-MACBETH software allows for sensitivity analyses to be performed. All changes on scores and weights are instantaneously reflected upon all other dependent values and graphics. A window in the software (see figure 5) is dedicated to the performance of sensitivity analysis on weight.

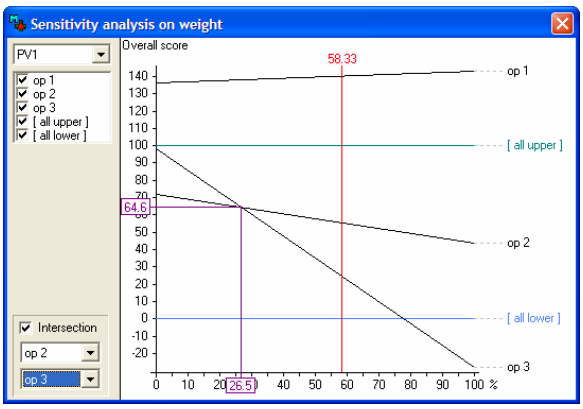

Figure 5 – Sensitivity analysis on the weight of “PV1”.

The software also offers a module for robustness analysis that can be used to explore the extent to which conclusions can be drawn given varying amounts of information, and differing degrees of

imprecision or uncertainty. M-MACBETH organises the information entered into the model into three types: ordinal, MACBETH and cardinal. Ordinal information refers only to ranking, thereby excluding any information pertaining to differences of attractiveness. MACBETH information includes the semantic judgements entered into the model; however, it does not distinguish between any of the possible numerical scales compatible with those judgements. In turn, cardinal information denotes the specific numerical scale validated by the decision maker. The robustness analysis module of M-MACBETH shows whether relations of dominance and global preference hold between options under varying amounts of information (see figure 6).

Moreover, when analysing the effect of cardinal information on the results, M-MACBETH allows a degree of imprecision to be associated with each criterion as a margin around each option's score. A similar analysis can be performed to explore the extent to which conclusions can be drawn given varying degrees of precision associated with the weights. Through robustness analysis, the decision maker is able to test whether hesitations on decision parameters are trivial to the model's results, or conversely, the cases that are worth investing resources to get into a deeper look.

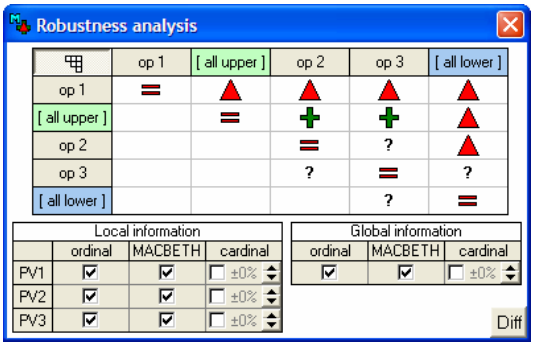

Figure 6 – Table of robustness analysis.

However, robustness analysis can also be seen in a different decision aid perspective. It may be that the decision-maker does not want to define numerical scores and weights, but rather opt for a pure qualitative analysis, just based on the (consistent) MACBETH judgements and using additive aggregation. In this perspective, after MACBETH judgments have been assessed and validated, one can skip the discussion of the numerical scales and go directly to the robustness analysis windows and select the MACBETH boxes in the local and global information tables, to display the overall comparison output for each pair of options (see figure 6).

The M-MACBETH software can be downloaded from the website:

http://www.m-macbeth.com

In the Demo version, saving is restricted to small models, but all other features are fully functional. To install either the professional or the academic edition, a license will be required. The User's Guide that comes with the software is available in four languages: English, Portuguese, French and Spanish.

Any additional information can be obtained at the following addresses:

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References:

Bana e Costa C.A., De Corte J.M., Vansnick J.C. (2005), "On the Mathematical Foundations of MACBETH", in J. Figueira, S. Greco and M. Ehrgott (eds.), Multiple Criteria Decision Analysis: State of the Art Surveys, Springer, New York, pp. 409-442.

Bana e Costa C.A., De Corte J.M., Vansnick J.C. (2004), "MACBETH", LSE OR Working Paper 03.56, London School of Economics, London.

Bana e Costa C.A., Chagas, M.P. (2004), "A career choice problem: an example of how to use MACBETH to build a quantitative value model based on qualitative value judgments", European Journal of Operational Research, 153, 2 (323-331).