Decisionarium – Aiding Decisions, Negotiating and Collecting Opinions on the Web

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1. ABSTRACT

Decisionarium (www.decisionarium.hut.fi) is the first public site for interactive multicriteria decision support with tools for individual decision making as well as for group collaboration and negotiation. Web-HIPRE (www.hipre.hut.fi) supports value tree and AHP analysis including group models. The RICH methodology (www.rich.hut.fi) allows the decision maker to provide incomplete ordinal preference statements when considering the relative importance of attributes in a value tree. Opinions-Online (www.opinion.hut.fi) is a platform for surveys voting and group collaboration. There are different ways for voting, multiattribute scoring,

surveys as well as interactive viewing of the results. Joint Gains (www.jointgains.hut.fi) applies the method of improving directions to support multiparty negotiations in a multicriteria setting. Smart Swaps offers an implementation of the even swaps procedure (www.smart-swaps.hut.fi). All of the tools above are web based so global interaction is natural and links can be utilized for multimedia information support. Decisionarium also offers access to complete elearning modules (www.dm.hut.fi) based on the use of the software. There are also illustrative powerpoint presentations and additional Windows software WINPRE and PRIME-Decisions for value tree analysis under incomplete information.

2. INTRODUCTION

Today the field of decision analysis has a growing number practitioners (see e.g. Keefer *et al.,* 2004, Hämäläinen *et al.,* 2004) and negotiations are becoming increasingly important in e-commerce applications (Lomuscio *et al.* 2003). The internet is a natural platform to deliver decision analysis tools for the use in personal as well as in public policy decision making. Yet, it is suprising to see that there are very few institutions developing and publishing general purpose web based DSS software. Here I will describe the Decisionarium which is a unique web site providing a family of software for different types of approaches to support

decision making and negotiations. The site includes the widely used Web-HIPRE software for multiattributre value tree analysis published already in 1998 (Mustajoki and Hämäläinen, 1998).

The Decisionarium tools are accessible with normal browsers. The available software make use of the possibilities of the internet as an information and communication channel. The internet is a global information repository offering useful information, which can be utilized e.g. when describing the decision alternatives in the decision making processes. The advantage of the web and the browser interface is that decision makers can use the software remotely without any installations on their local computers. Web software is a prerequisite for public participatory e-democracy projects. The internet also makes global group decision making processes possible, as participants can work together with the same software. The different software can also be in parallel use to support and augment the analysis processes. The Decisionarium site and the software included are intended to contribute to the development of the field and stimulate the use of the methods in teaching and practice. The site can be used for noncommercial academic purposes and as a preliminary test site for professional applications in industry, public administration, research institutions and universities.

The site is not intended to be a supported service provider for commercial or permanent users. Users can purchase the software for their own intranet or internet

installations. It should also be pointed out that the software can also be used on independent computers and laptops by installing a server software in them.

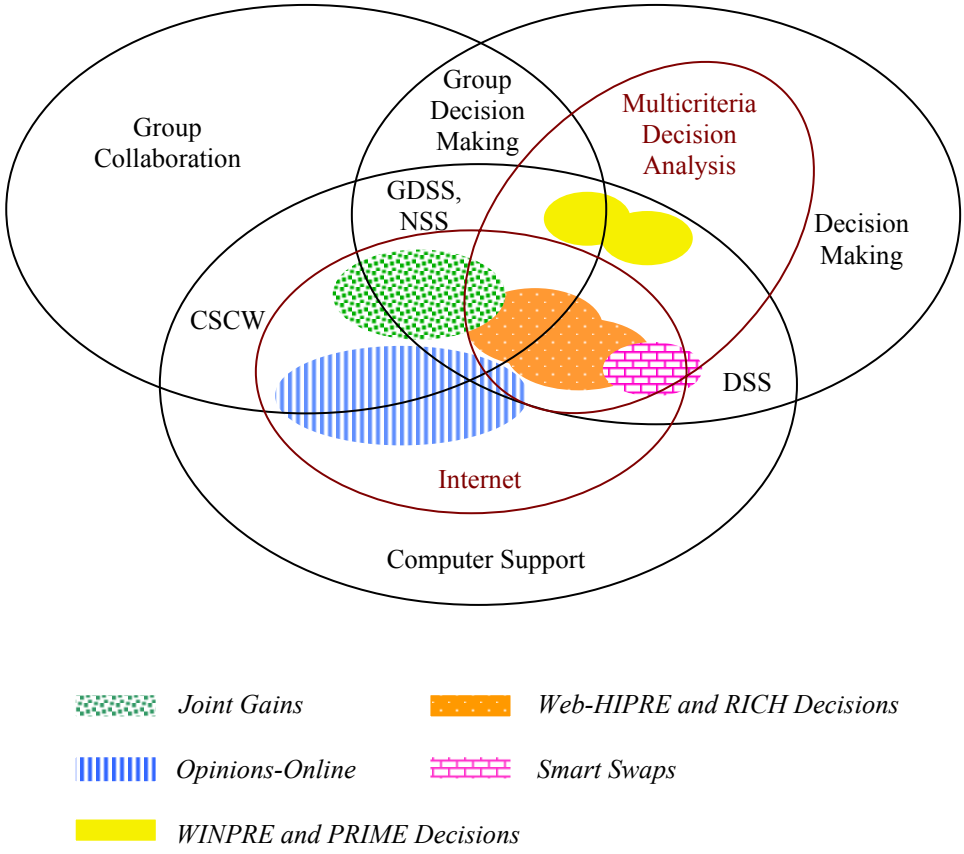


Figure 1. The world of decision support and the software tools of Decisionarium

3. OPINIONS-ONLINE

Opinions-Online (Hämäläinen and Kalenius, 1999) is a platform for group collaboration by surveys and voting. One can very quickly create and edit a

questionnaire with immediate access to the results. Users can customize their own surveys, and there are different ways to collect and view the results. In the basic version the voting methods include approval voting, ranking of the alternatives and multiattribute rating of the alternatives. Surveys can be conducted with any number of questions and written comments can also be collected. The software is directly applicable to teledemocracy and citizens' participation in public policy (see e.g. the site www.paijanne.hut.fi and Mustajoki *et al.* 2003b). Moreover, many types of group processes, including the Delphi method, can be supported by this system. There also is a version of Opinions-Online (www.opinion.vote.hut.fi), which provides a set of advanced voting rules, where the results are derived from the ranking of the alternatives.

There are a number of useful features to be mentioned. Opinions can be collected openly, restricted by domain or participant specific passwords. The system provides an opinion barometer when personal registration is used. Then the entry is updated each time a new revised opinion is submitted. The results can also be viewed by sampling the opinions by any set of fields in the survey. The direct way of analyzing the results through the web are useful especially in group settings.

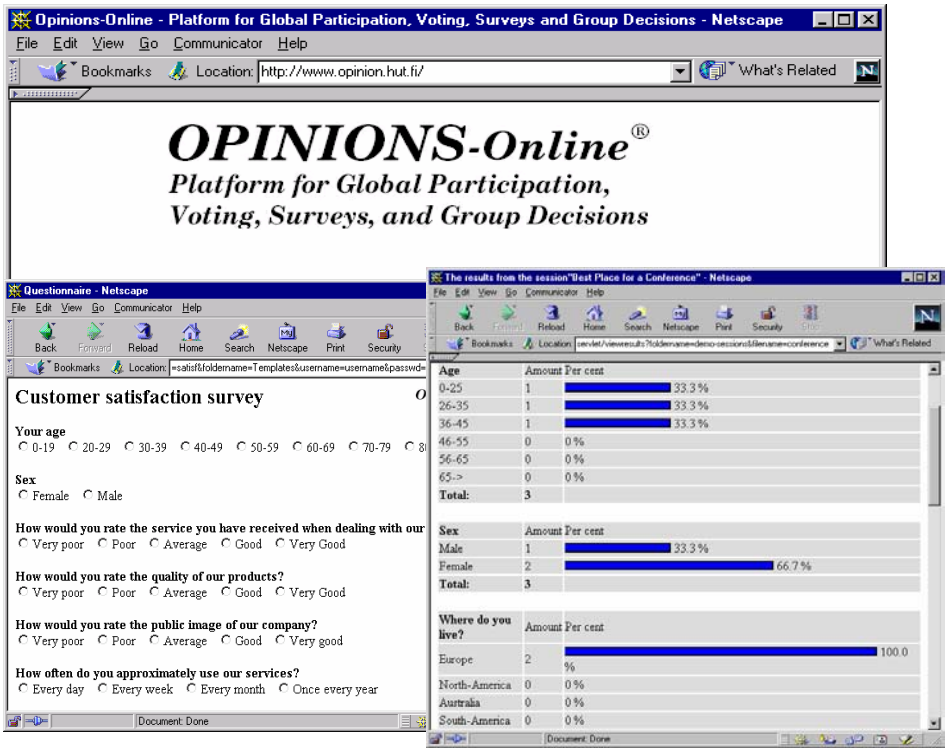


Figure 2. Opinions-Online: Platform for global participation, voting, surveys, and group decisions

4. WEB-HIPRE

Web-HIPRE (Hämäläinen and Mustajoki, 1998; Mustajoki and Hämäläinen, 2000) is a web tool for supporting different phases of a multiattribute decision analysis process, i.e. modeling the problem, weighting of attributes, evaluation of alternatives and analysis of the results. The software is a Java implementation of the original HIPRE 3+ DOS software (Hämäläinen and Lauri, 1992) with the same

features. With the graphical user interface, all the phases can be carried out visually. The weighting methods include SMART, SWING, SMARTER and AHP. Value functions are also easily available. Different methods can be used in parallel and this allows the easy comparison of the results obtained by different methods, The scale used in the AHP can also be general and thus the scale related problems are avoided (Salo and Hämäläinen, 1997). These features are very valuable for practitioners and educators. For a comparison of the weighting methods see e.g. Pöyhönen and Hämäläinen (2001).

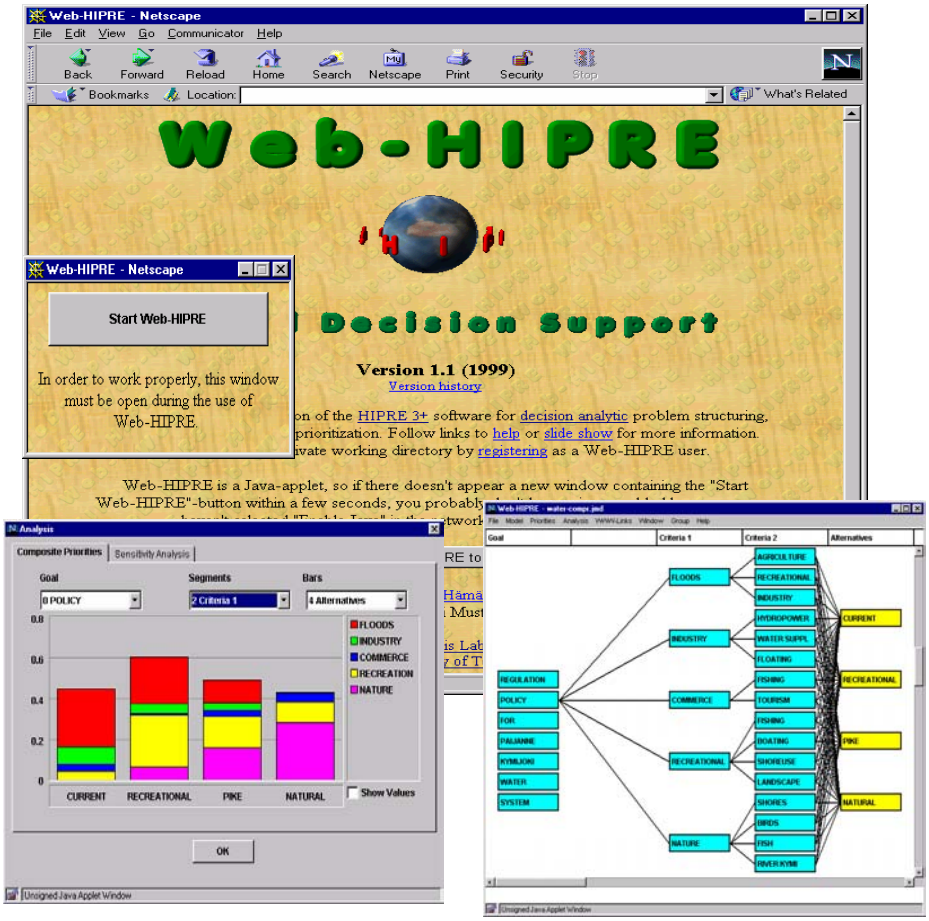


Figure 3. Web-HIPRE for value tree and AHP based decision support

A group model can be used to aggregate the individual models via the internet with the weighted arithmetic mean method. The results can be examined with single parameter sensitivity analyses. The elements, attributes or alternatives, of the model can be directly linked with web pages containing, for example, multimedia information about the element. This property can be very useful in environmental problems as well as in product comparisons in e-commerce applications. For Web-HIPRE applications see e.g. (Levy *et al.*, 2000; Mustajoki *et al.*, 2001 and 2003b; Tsvetisov, 2003).

5. RICH DECISIONS

The RICH (Rank Inclusion in Criteria Hierarchies) methodology (Salo and Punkka, 2003) allows the decision maker to supply incomplete ordinal preference information about the relative importance of attributes in a value tree. For example, he or she may state that some attribute is among the three most important ones, or that the most important attribute comes from a particular subset of attributes. Full support for this methodology is given by the RICH Decisions decision support tool (Salo *et al.*, 2003). To-date, this tool has been applied to the selection risk analysis

methods at an energy utility (Ojanen *et al.*, 2003) and the collaborative development of priorities for a research program (Salo and Liesiö, 2003).

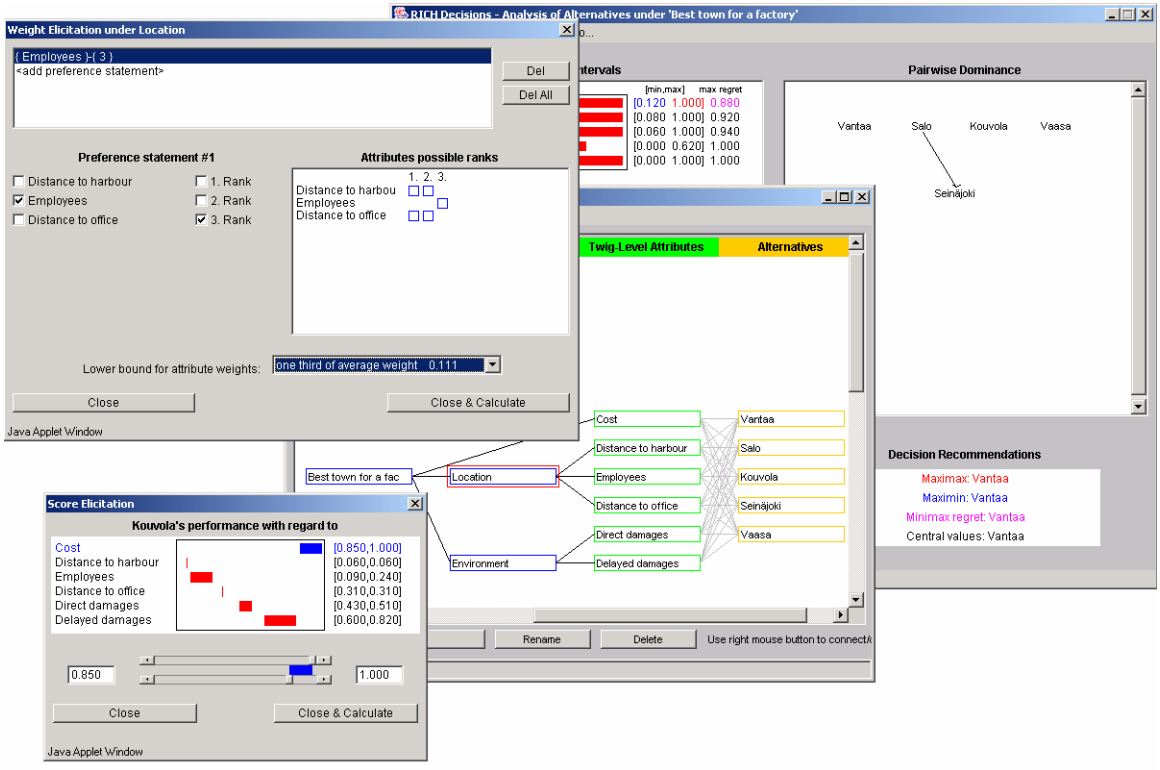


Figure 4. RICH Decisions decision support tool.

6. JOINT GAINS

Joint Gains (Kettunen *et al.,* 1998) is an implementation of the method of improving directions (Ehtamo *et al.,* 1999, 2001) to support multi-party multi-attribute negotiations. Joint gains are searched starting from an initial point, for

example, a previously made agreement. The jointly improving direction is based on local preference information collected from the participants with simple pairwise questions, see Figure 5. Gradually, the system guides the participants towards a Pareto-optimal agreement. Basically, the method of improving directions is a mathematical formalization of the single negotiation text (SNT) procedure, which has been presented by Raiffa (1982; Chapter 14).

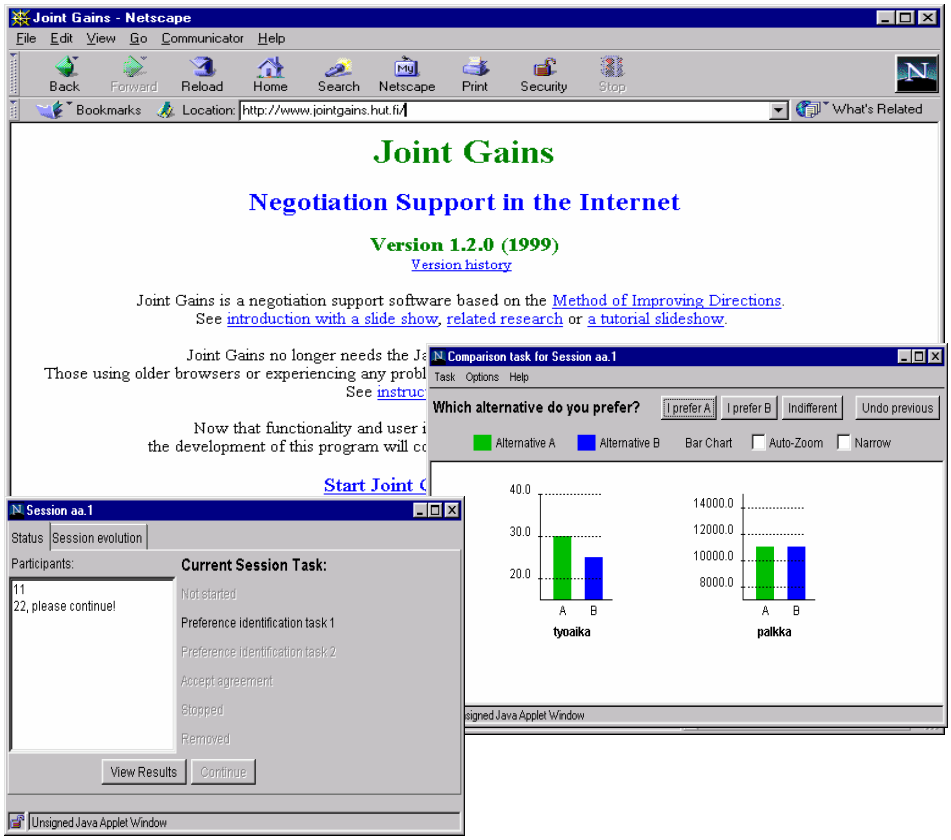


Figure 5. Joint Gains - Multi-party negotiation support with the method of improving directions

Typical areas of applications include environmental policy problems (Hämäläinen *et al.*, 2001) and the automatic facilitation of negotiations in e-commerce. For general reviews and classifications of e negotiation models see e.g. Kersten and Noronha 1999 and Lemuscio *et al.*, 2003. The Joint Gains software has been successfully applied as an interactive training tool in the elearning of negotiation analysis (Ehtamo *et al.*, 2002, 2004).

7. SMART SWAPS

Smart Swaps (Hämäläinen *et al.*, 2003) is a web software for supporting the Even Swaps method (Hammond *et al.*, 1998, 1999). The basis of the method is to make the alternatives dominated and attributes irrelevant by carrying out value trade-offs, i.e. even swaps. These alternatives and attributes can then be removed from the analysis, and the process continues until there only remains one alternative, i.e. the most desired one.

Smart Swaps also provides new procedural support for the method (see Mustajoki and Hämäläinen, 2003). For example, the software automatically identifies

dominated alternatives and irrelevant attributes, and keeps track of the steps taken during the process which allows backtracking. The decision maker can also ask the software to suggest suitable candidates for the next even swaps. Help in the procedural tasks allows the decision maker to concentrate on the trade-off judgments. The software also provides visual support for the problem. For example, different color tones can be used to represent the ranking of the alternatives on each attribute.

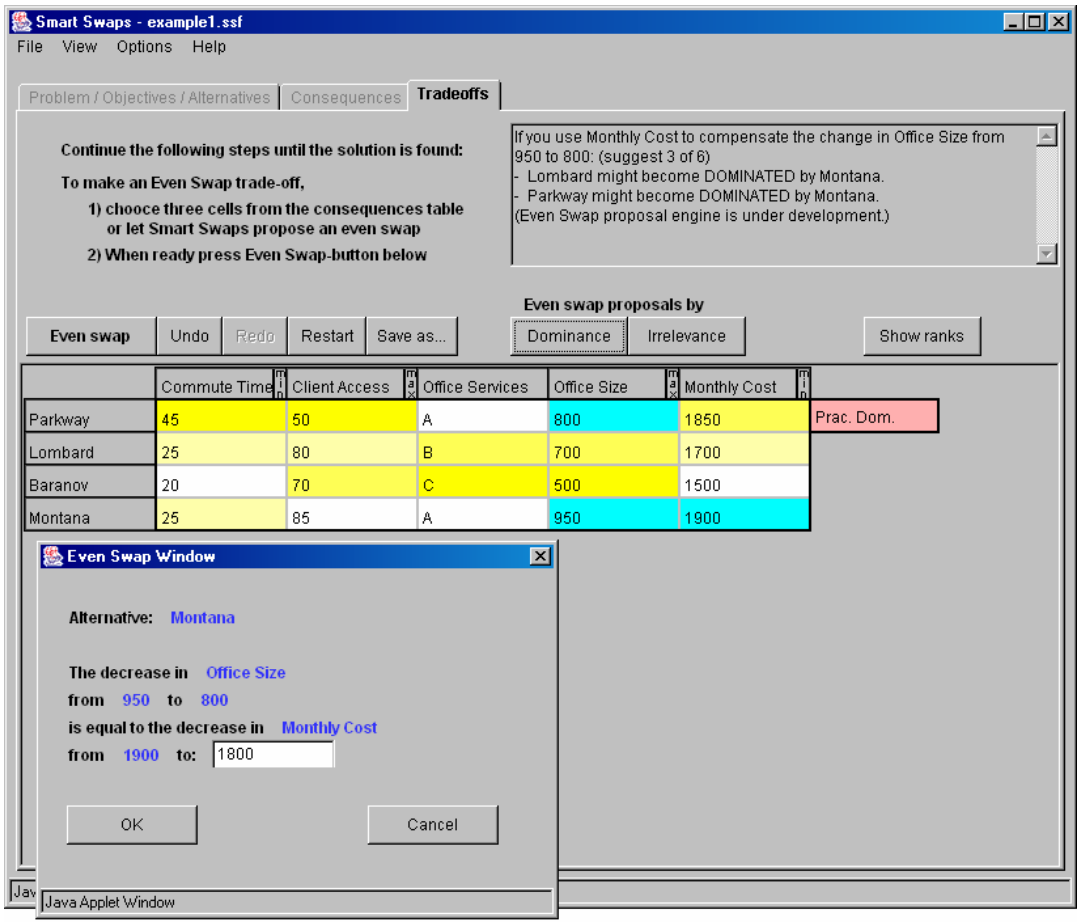


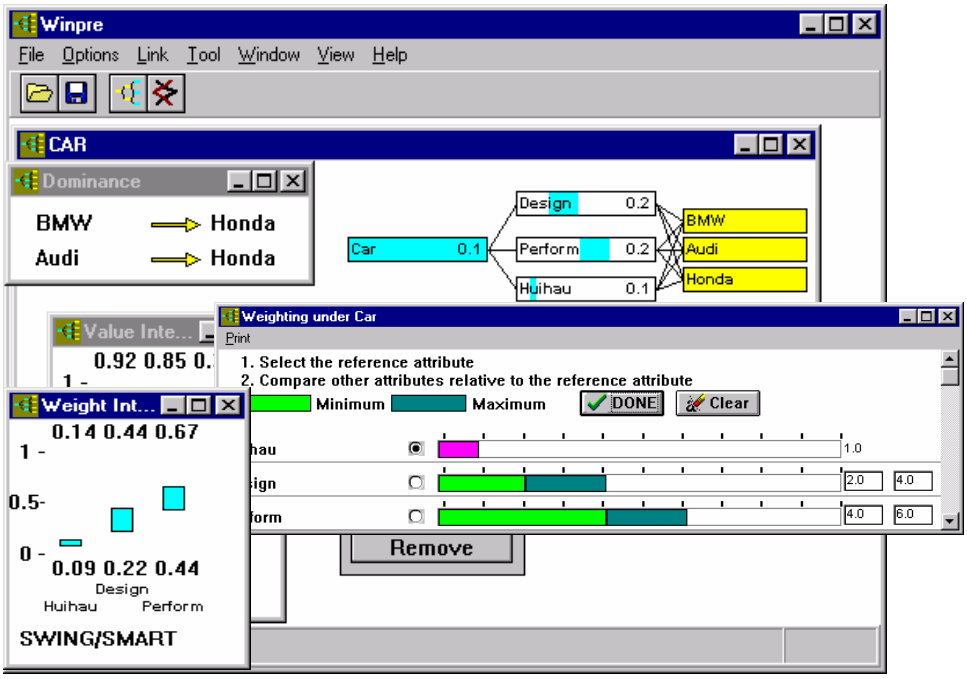
Figure 6. Smart Swaps – Smart Choices with the Even Swaps method

8. WINPRE AND PRIME DECISIONS

Besides the above described web software, there are also two Windows software downloadable on the Decisionarium site: WINPRE – Workbench for Interactive Preference Programming (Hämäläinen and Helenius, 1998) and PRIME Decisions (Gustafsson *et al.,* 2000). These software support multicriteria decision analysis (MCDA) under incomplete information.

Both software provide interval techniques for multiattribute value tree analysis (for a review see Salo and Hämäläinen, 2003). The intervals can represent either the uncertainty (Lindstedt *et al.,* 2000) or the range of preferences in a group of decision makers. This is a new way of embedding individual models into a group model (Hämäläinen *et al.,* 1992; Hämäläinen and Leikola, 1996; Hämäläinen and Pöyhönen, 1996). WINPRE supports the Analytical Hierarchy Process (AHP) with interval judgements, this approach is called preference programming (Salo and Hämäläinen, 1995), as well as the PAIRS and interval SMART/SWING methods (Salo and Hämäläinen, 1992; Mustajoki *et al.,* 2003a). PRIME Decisions (Gustafsson *et al.*, 2000) is an implementation of the PRIME method (Salo and Hämäläinen, 1999). It has been applied, for instance, to the valuation of a high-technology company (Gustafsson *et al.*, 2001). The use of the PRIME Decisions is

illustrated in our multiple criteria decision analysis elearning site (Hämäläinen and Dietrich, 2002) in a case study on car selection.



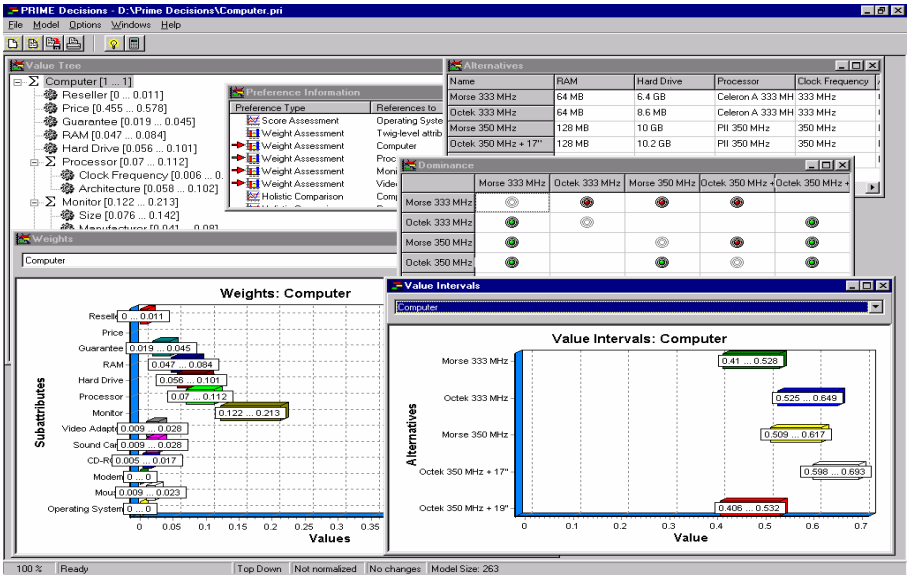


Figure 7. WINPRE for PAIRS and interval AHP/SMART and PRIME Decisions

9. ELEARNING

The Decisionarium also provides access to our elearning sites on multiple criteria decision analysis (Hämäläinen and Dietrich 2002) and negotiation analysis (Ehtamo *et al.* 2002). The elearning sites have an architecture based on XML, which allows the customization of learning modules and learning paths for different users. The generic structure of our learning modules is presented in Figure 9. The modules contain theory sections, case studies and assignments. They also include quizzes for self-evaluation and video clips illustrating the use of the software. Thus the elearning modules provide a way to learn the use of the software available in the Decisionarium as well. Currently the software used in the elearning modules are: Value tree analysis (Web-HIPRE and PRIME-Decisions), Group decisions and voting (voting version of Opinions-Online) and Negotiation analysis (Joint Gains).

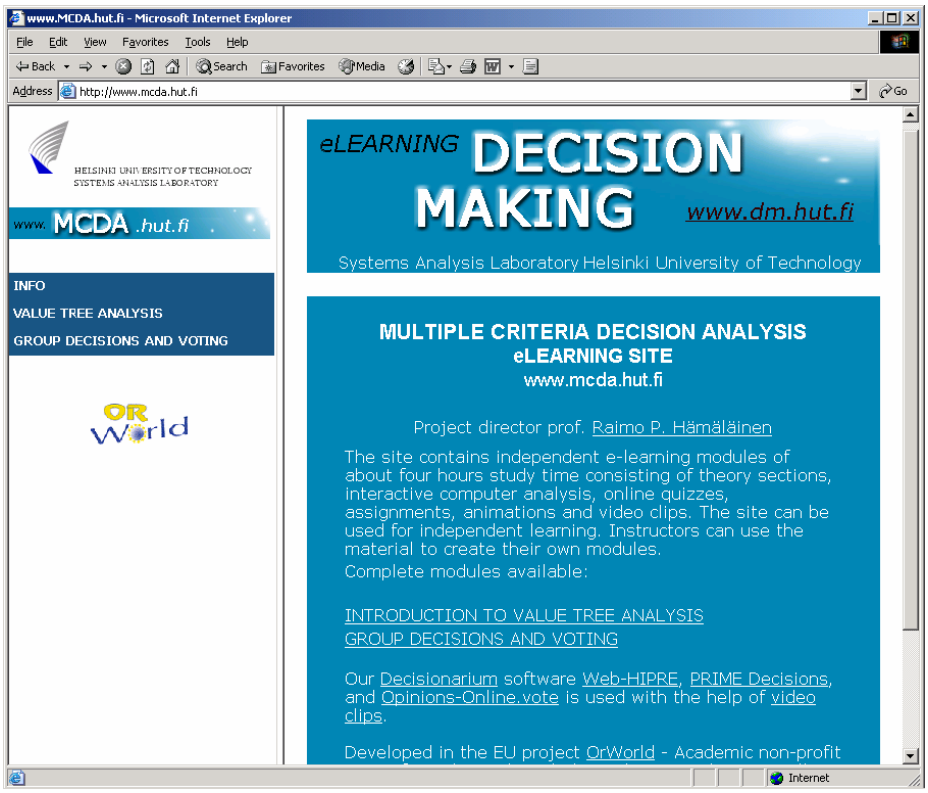


Figure 8. Multiple criteria decision analysis elearning site

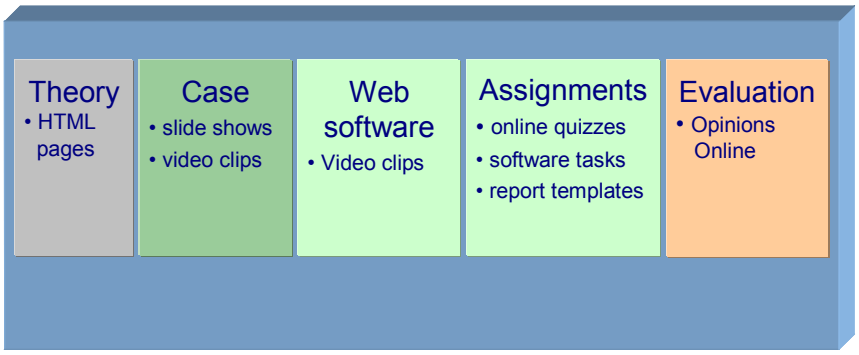


Figure 9. Structure of the elearning modules representing 2 to 4 hour sessions

10. SUMMARY

The software in the Decisionarium can be used both individually and as a family of modelling tools. As an example of the parallel use of the software consider a decision or consensus seeking conference held on the internet. Under conflicts of interest we first need to start by searching for a set of Pareto optimal policy alternatives with the Joint Gains software. Web-HIRPE can be used to structure the problem and analyze the alternatives with the multiattribute value tree approach. Opinions-Online can then be used to gather user comments from the group or perhaps from a larger group of stakeholders. Approval voting can be used to evaluate the alternatives on the basis of the analysis. We have tested the set of software available in Decisionarium in this manner in an environmental management project (see e.g. www.paijanne.hut.fi) (Hämäläinen *et al*., 2001). In general the growing interest in edemocracy also increases the need for web based tools to support complex decisions. The Decisionarium site provides an important open source of resources for education but also for researchers testing tools in public policy and environmental management as well as in e-commerce. One of the main advantages of web-software is the maintenance and easy access. In this way one can develop elearning materials and test the methods independent of problems related to software installations.

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