3

The DELTA Decision Tool

This chapter is a demonstration of DDT – the DELTA Decision Tool. DDT is built on top of DELTALIB, a set of library procedures that together implement the DELTA method as described in Part II of the thesis. The chapter is divided into three sections. The first section describes the DDT software and its architecture. The functionality of the software is most accessibly conveyed by an example. Thus, the middle section introduces a decision problem on which the sample session in the last section is built. The chapter is intended to continue the informal overview from Chapter 2. As in that chapter, the purpose is to provide an intuitive overview of how the method works and to demonstrate that the suggested method is realistic to work with.

The DDT Software

The DELTALIB library is the core of DDT [D96]. It consists of several modules collected into a library with a common published programming interface in the form of callable C functions and procedures. The layered architecture of the library is shown in Figure 3.1. The lowest layer, the *solver layer*, consists of different optimising solvers for linear and bilinear programming as described in Chapter 6. There is a solver stack consisting of a number of solvers that solve progressively harder

problems of optimisation. Further, there resides other algorithms such as graph algorithms for special purposes.

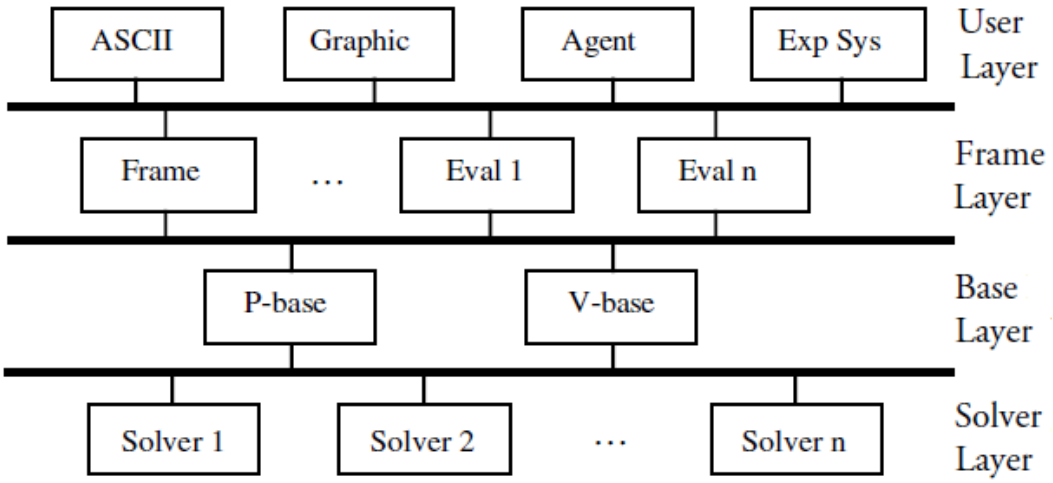

Figure 3.1 The DELTALIB layers

The next layer, the *base layer*, contains functions for the probability and value bases. Among the functions are data structure access, consistency maintenance, and tests for orderings. This layer calls the solver for tasks that involve optimisation, for example calculating the orthogonal hull of the probability base.

The *frame layer* is the library's interface to the callers. It provides a programming API[1] to the library functions and capabilities. It contains a scheduler, consistency and maintenance functions, and integrity checks to protect the rest of the library from erroneous calls. Further, it contains the evaluation modules for the DELTA and GAMMA rule sets (explained in Chapter 5), and for the PSI and OMEGA rule sets not explicitly covered in the thesis. Finally, it contains the procedures for security levels. The layer may be extended with other functions in the future, for example evaluations using other Δ-dominance concepts or numerical rules other than the expected value.

The *user layer* consists of different library users. The library is equally well designed for use by a textual user interface, a graphical user interface, an agent (a robot, for example), or an expert system. Of these,

instances of the two leftmost exist today, and the third from the left is underway as software agents using World Wide Web techniques. An instance of the second one from the left (Graphic) is DDT, the topic of the rest of this chapter [D97a].

The Decision Problem

This section presents an example of a decision problem suitable for investigation using the DELTA method. A medium-sized Swedish manufacturing company relied in one of its most important production lines on an old machine, to which spare parts had become increasingly hard to obtain. At a critical moment, the machine broke down in a more serious way than previously. It became clear to management that the machine was a potential danger to future operations unless it was either thoroughly repaired or replaced by a new machine.

A DDT Session

Currently, DDT runs on Windows 95 PCs and Unix workstations, and it is from the latter implementation that this session is taken. When the program is launched without a pre-existing data file, a default decision problem is created. Apart from the traditional **File** menu, the top level menu in DDT consists of the following items:

Settings

- Show hull values
- Utility settings
- Zoom
- Security levels

Evaluations

- Absolute
- Relative set
- Alternative 1
- Alternative 2
- Security check

Table 3.1 Main pop-down menus

NOTE: Due to severe problems with editing and printing this chapter, the PDF reprint will mostly contain the figures (screenshots) from the presentation of the tool. If the chapter is allowed to be more extensive than this reprint, it is not editable in either Word 5.1 or 6.0, neither convertible to a PDF file. Originally, the chapter consisted of pages 47–64 but it is not possible to recreate in its entirety. Only this chapter is affected by these editing problems.

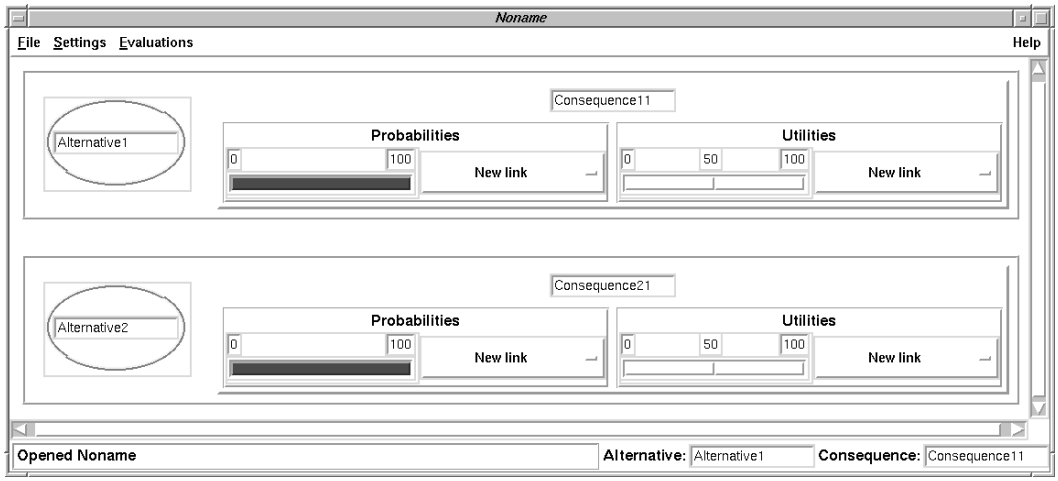

Figure 3.2

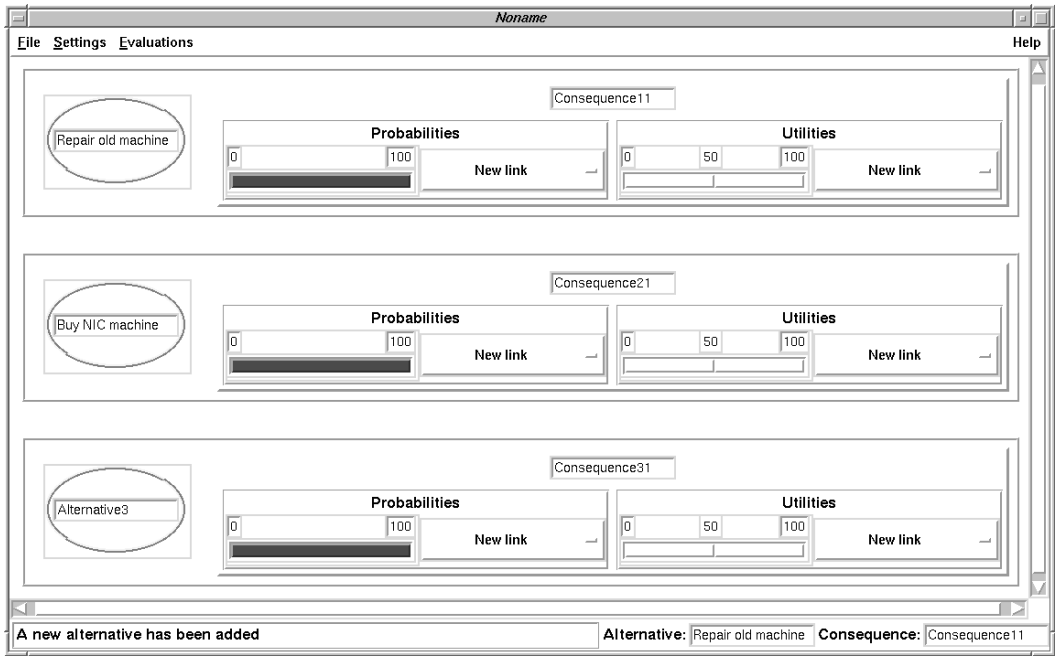

Figure 3.3

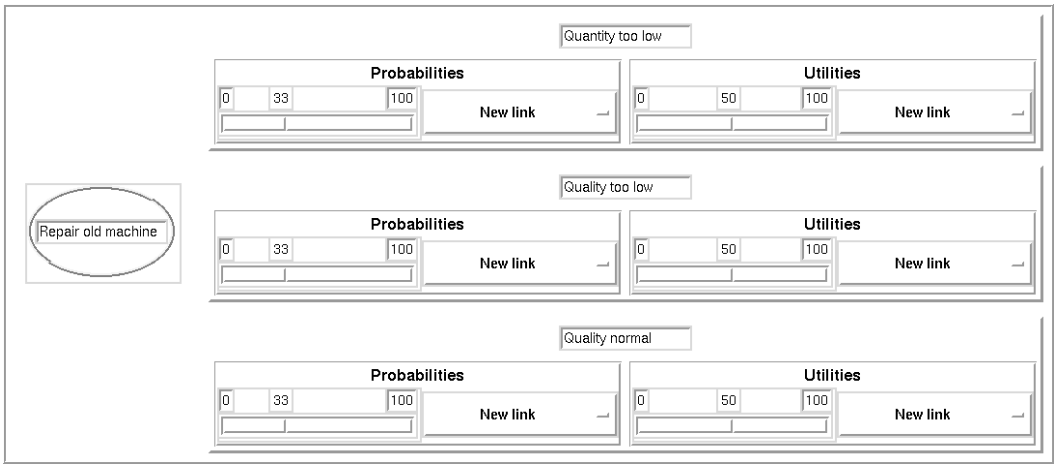

Figure 3.4

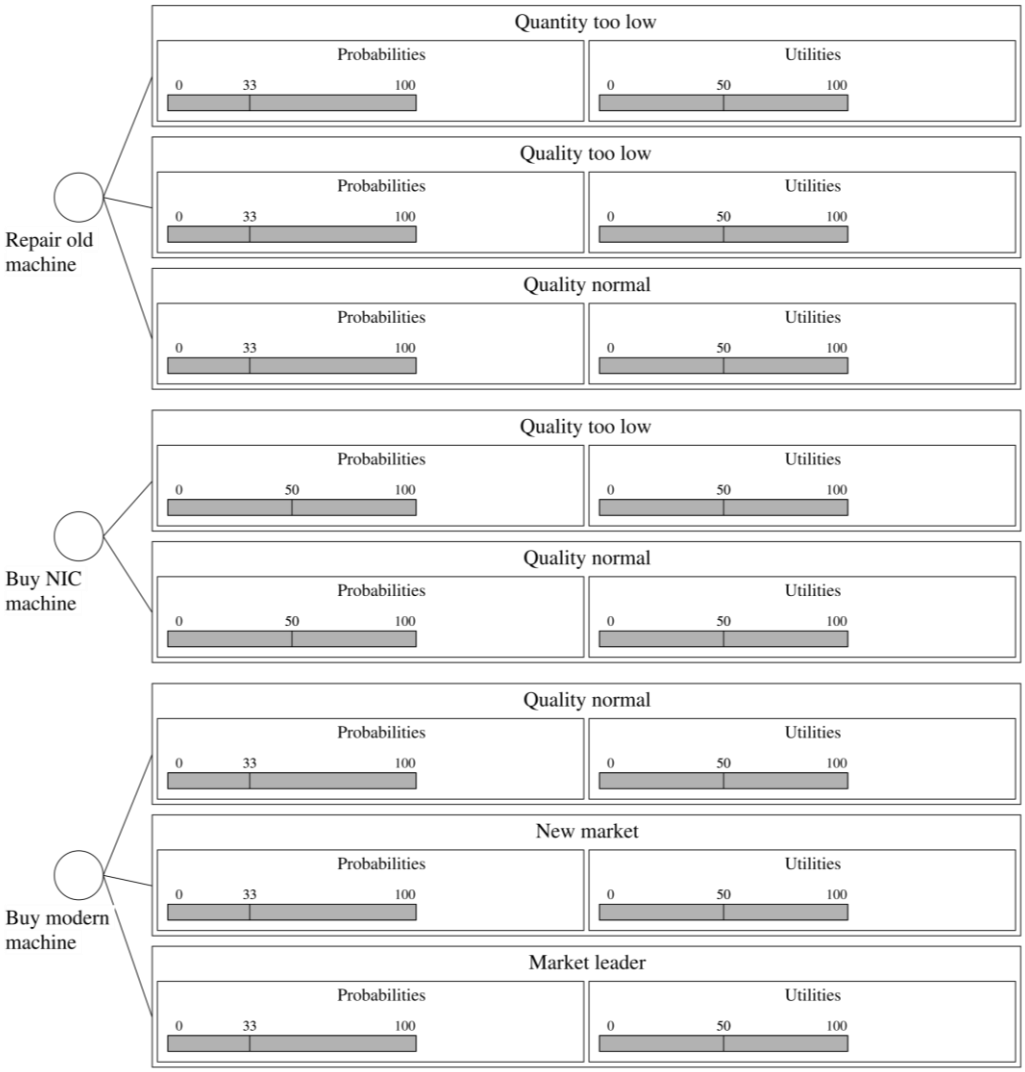

Figure 3.5

User Statements

To begin with, it is assumed that the decision maker is content with the tree and wants to move on to entering probabilities and values. This is done either by dragging the interval endpoints using the mouse or by entering the numbers manually. The interval is modified interactively, and feedback is given if the base is becoming inconsistent as a result of altering an interval. An important difference between probabilities and values is the familiarity among decision makers with [0,1] variables. For probabilities, numbers in the range [0,1] (in the form 0% to 100%) are commonly accepted. For values, on the other hand, the range [0,1] is not the most natural nor the most common. Therefore, as was shown in Figure 3.1, DDT allows any range for the values, even such where greater utility is derived from smaller values, as is the case with for example pollution.

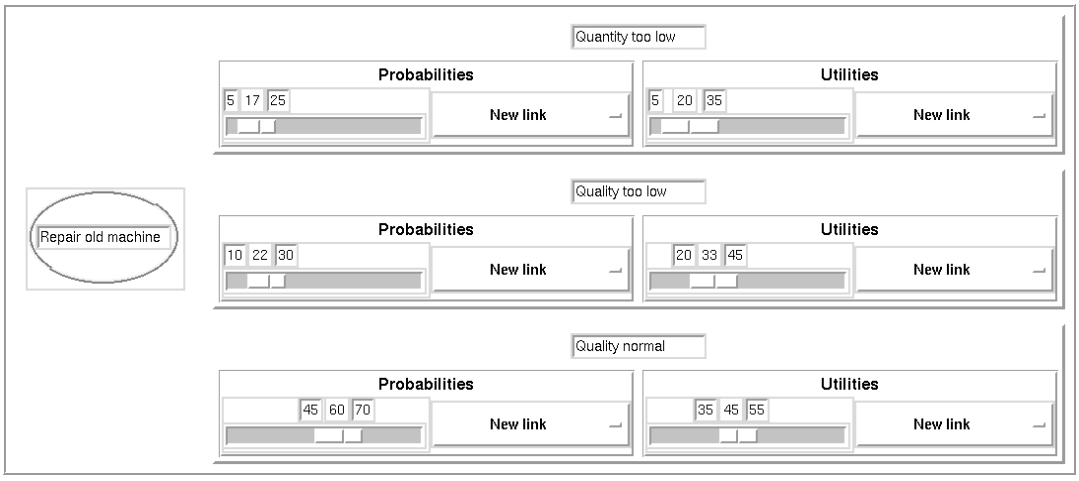

Figure 3.6

A default focal point is suggested by DDT when the decision problem is entered. It can be modified by the decision maker at any time during the evaluation, as long as it is kept consistent. The consistency of the information is maintained by DDT. After the probabilities and values have been entered for the other two alternatives as well, the DELTA decision tree looks like Figure 3.7.

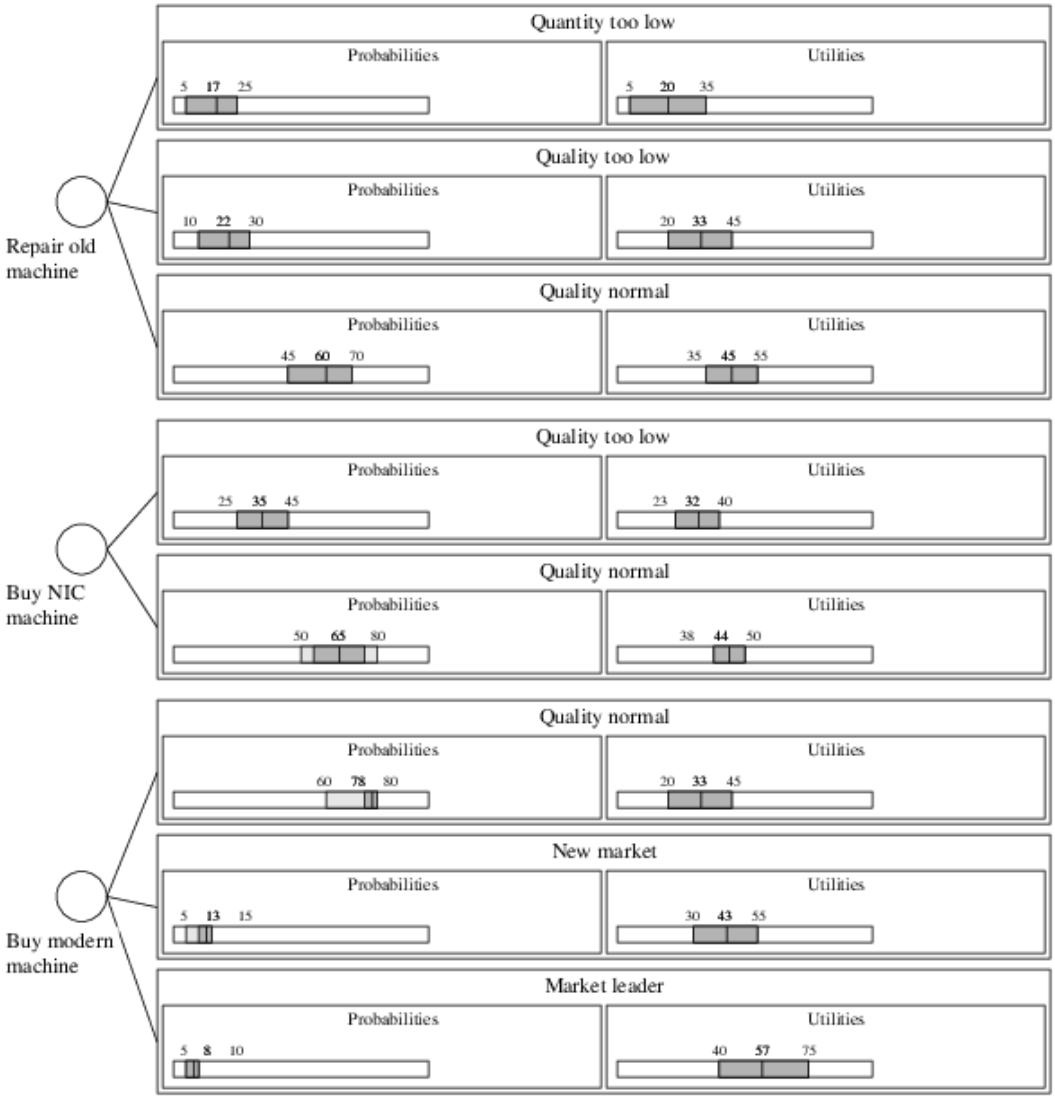

Figure 3.7

Evaluation

Now that all initial information is stored properly in the tree, the evaluation phase can begin. Each evaluation takes place in a separate window, and there may be more than one window active at the same time. In each window, there is a possibility to customise the appearance of the evaluation graphs. The following three pop-down menus are available in the DDT decision analysis tool:

Misc
(see Figure 3.8 below)
Add
(adds a graph to the display)
Delete
(removes a graph from the display)

Table 3.2 Evaluation pop-down menus

In the 'Misc' menu, it is possible to choose which of the maximal, medium, and minimal values are to be shown for the current comparison. In this sample session, it was chosen to compare the alternatives pairwise and then to view the medium differences in the graph. It can be seen in Figure 3.8 that only 'Show mid' is selected and in Figure 3.9 an evaluation mid result for two alternatives is shown.

Figure 3.8

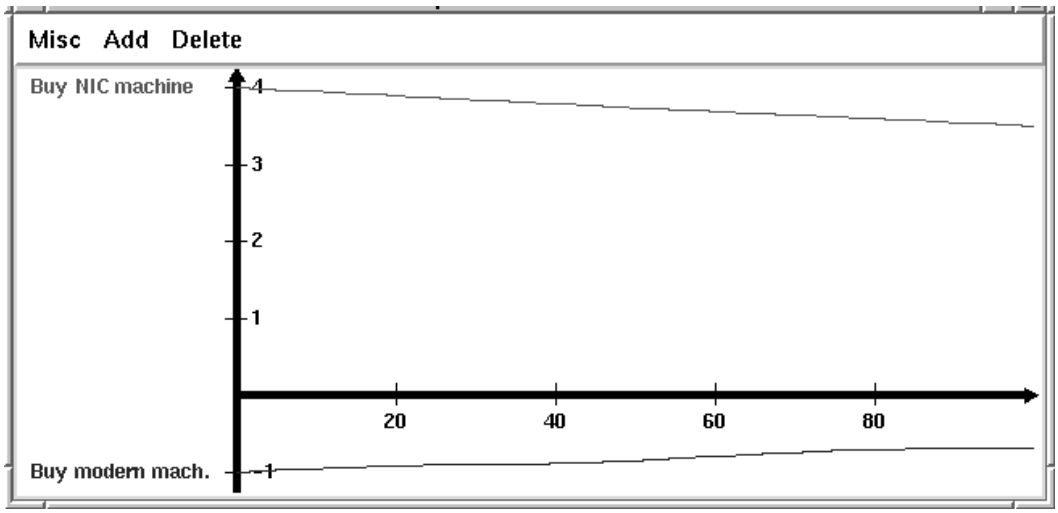

Figure 3.9