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QL·Decision Maker

BRAINPOWER

Software by

Triptych Publishing Ltd.

Contents

QL.Decision Maker

Real problem solving with your micro

Text book by Stuart Armstrong
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Programs by Peter Jollyman
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Getting Started

QL. Decision Maker has been designed to cater for people with a wide range of backgrounds and skills. Many of you will therefore not need to read through this text from cover to cover in order to use the computer programs. To accelerate your progress, we suggest the following:

A. If you already understand the principles of Decision Analysis and Decision Trees, simply turn to Chapter 12, where you will be given detailed instructions on how to use the Applications Program.

B. If you understand what Decision Analysis is, but don't know how to apply it, then turn to Chapter 1, and follow the instructions on how to use the Teaching Program.

C. If you are starting from scratch, if you don't have your computer handy, or if you simply want to take a more leisurely approach, then please read through the Introduction before you go any further.

NOTE
If you are not familiar with the procedures required to load the Teaching or Applications Program into your QL, refer to Appendix 2, where you will find specific instructions for loading **QL. Decision Maker**.

Introduction

Welcome

Titles in the **BRAINPOWER** series are uniquely designed to harness the power of your home computer to enable you to learn new skills in a simpler and more enjoyable way. The sophisticated interactive approach ensures that you can work at your own pace and, once you have mastered the topic, the Applications Program will continue to serve your needs. We have made every effort to create a course which is straightforward to use, but if you think that we could improve upon it, please write to us on the card included in the pack.

QL. Decision Maker is a complete learning and applications course based upon the theory of Decision Analysis and Decision Trees. Your purchase consists of three elements:

1 The Text Book which you are now reading. Please bear in mind that you will be using it continuously in conjunction with your QL.

2 The Teaching Programs, which will be used to give you a full understanding of the concepts of Decision Analysis.

3 The Applications Program, which you will be able to use to solve your own decision analysis problems.

You will find that the Teaching Programs are not a simple tutorial on how to use the Applications Program. Once you gain an understanding of the material, you will be able to use decision analysis to solve problems with or without your computer.

If you think that you already have a sound grasp of the principles of decision analysis, then you may wish to try out the Applications Program immediately. If so, go straight to Chapter 12. There you will discover the detailed instructions for solving your own decision problems.

Decision Analysis

The techniques presented in **QL. Decision Maker** can be used to perform an explicit analysis of a particular situation, and reveal the appropriate strategy to adopt. Your role as decision maker is simplified because you can see how various actions taken now generate different outcomes in the future. It is this structuring of the decision problem, combined with a means to measure the value of the decision which is the key attribute of Decision Analysis. You can 'unbundle' the problem – breaking it down into sequential component parts, and this process will lead you to a more enlightened view of the options, allowing you to take greater control over the pattern of future events.

QL. Decision Maker is a powerful tool for anyone interested in strategy and decisions in all walks of life, who wants to minimise the risks involved. Even at their most basic, these procedures will allow you to project yourself into the future with confidence and dexterity, assured of a more logical understanding of the problem addressed and its solution in terms of your own requirements.

For the newcomer to this topic, we should explain what kinds of problem can be solved by decision analysis and how the process is applied. It is important to appreciate that not all decision making problems can be easily resolved by this method. Other techniques, such as Linear Programming, Discounted Cash Flows, Critical Path Analysis and so on are more appropriate for some situations. To use decision analysis, it must be possible to break the problem down into a finite number of elements in the following way:

1 There is an initial decision to make, and there is a limited number of clearly defined alternatives from which to choose.

2 For each decision, there is a limited number of possible alternative outcomes.

3 Each outcome could lead to another decision with another series of possible alternative outcomes, and so on.

The technique of analysing the decision involves drawing a diagram of the process in a symbolic form. In fact the actual process of constructing the diagram, known as a 'Decision Tree', will help to make a very complex decision look somewhat simpler.

Once the problem is dissected in this way, we need a means of judging the value of the decision. In business, this is usually measured by cost or profit, but in other circumstances, the value could be assessed, for instance, in terms of the number of lives saved, or the number of jobs created or some other non-cash figure. We must then be able to estimate the 'value' of each decision and outcome, so that the initial decision which leads to the highest value can be selected.

The application of **QL. Decision Maker** techniques to a wide range of situations is a powerful management tool for a number of reasons:

1 It compels you, the person making the decision, to recognise the structure of, and the relationships between the elements involved.

2 You must systematically value all of the possible actions and outcomes, and once again this demands that you consciously review each aspect of the decision.

3 You can modify the costs, values and risks of the various activities involved and test them to find out how much things need to change to make you alter your initial decision.

In summary, **QL. Decision Maker** will provide you with the skills to apply this sophisticated technique to a multitude of decision problems, both in the home and at work, and will enable you to take full advantage of the investment you have made in your QL.

The actual procedure is really quite straightforward, but do not be concerned if you are a little confused by this first explanation of the process, because the Teaching Programs will work through it all in rational stages.

Chapter 1

The Teaching Program

1.1 Teaching Method

Before we move into the stage of actually learning anything, we will quickly review how the computer is going to be used in conjunction with this book. First of all, you will find that all written explanations of the subject will appear in the book. We don't think that you want to strain your eyes reading computer screens full of text, and anyway computer memory is a relatively expensive medium for storing the written word. Because of this principle, you will be switching back and forth between book and screen all the time, so set the book next to the computer where you can refer from one to the other easily. You will find it useful to have a pencil and paper handy as well. The screen will be used to show you examples in operation and to present you with exercises so that you can check your own understanding.

As you work your way through the book, you will be asked to operate the computer by pressing certain keys. This is so that the computer knows which point you have reached. Any key you need to press will be highlighted in the text such as **SPACE** or **4**. Likewise, when the computer wants you to return to the book, it will direct you to your place by giving you the number of the relevant chapter sub-heading.

1.2 The Six Step Process

Decision Analysis can be thought of as a six step process, leading from a general concept of the nature of the decision through to a specific solution. Each step will be explained briefly in the worked example demonstrated in Chapter 2, and then covered in detail in the subsequent teaching chapters. The steps can be defined as follows:

1 STRUCTURE – Sort out what the various decisions are that have to be made, in what order they arise, and what chance events occur

in between. The various decisions and outcomes are then drawn out in a symbolic form, called a 'Decision Tree'. – This is explained in Chapter 3 of the book.

2 PAYOFFS – Work out the costs and values of all the events involved. – Explained in Chapter 4.

3 PROBABILITIES – Estimate the likelihood of each of the chance events occurring. – Explained in Chapter 5.

4 ROLL-BACK – Use the decision tree analysis rules to calculate the solution. - This is the key step of the process, and it is explained in Chapters 6 and 7.

5 RISK ANALYSIS – Check out the calculated solution to ensure that all possible outcomes can be tolerated. – Chapter 8.

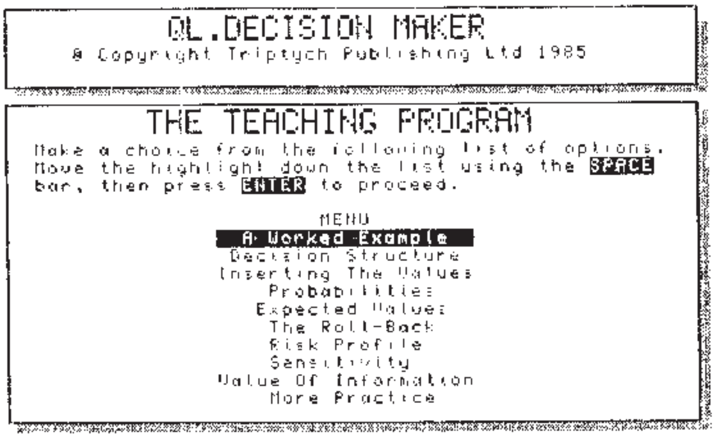
6 SENSITIVITY ANALYSIS – Find out how much your assumptions have to be changed to change the solution. – Chapter 9.

There is also a chapter on the concept of 'Value of Information', a more sophisticated concept which only becomes relevant once a decision can be analysed in detail.

1.3 Getting Started

Instruct your QL to load in the Teaching Program. If you are a newcomer to computers, there are some reminders for you in Appendix 2. Be sure to place the cartridge labelled Teaching 1 in Microdrive 1 and Teaching 2 in Microdrive 2. The Program will start automatically, and when you press the SPACE key, it will display a list of options from which you can choose. The options relate to the Chapter headings in the text book. You make your choice by using the SPACE and ENTER keys. Each time you press SPACE, the black bar will move one step down the list, and if it is at the bottom, it will jump to the top. When the bar is on the item you wish to select, press the ENTER key, and the computer will act on your choice. This type of selection list will be referred to as a **MENU** from now on.

When you use the program for the first time, you should select the first option, 'A WORKED EXAMPLE', from the menu, but on subsequent occasions, you can choose the option for the particular unit you wish to study.



Once an option has been selected, the computer will have to load another section of the program.

When the correct section is loaded, the computer will give a message confirming the name of the unit and it will point you to the correct chapter in the book. Once any one unit is completed, the program will always give you the option of repeating the unit, stopping or returning to the main Menu. From time to time, instructions will be displayed on the screen which are not mentioned in the book. Always read and follow these instructions carefully.

Before you begin, remember to equip yourself with a pencil and paper, in order that you can make notes and sketches as you go. You should also be prepared to concentrate on a unit for quite a long period of time, for although we have made each step as simple as possible this is not a trivial subject to study. There will be plenty of opportunities to rework sections and ensure complete understanding, and of course plenty of practice to build your confidence.

Chapter 2

A Worked Example

2.1 The Problem

Let us assume that you have decided to buy a five year old Ford Escort, and you only have a choice of two cars. They both look exactly the same, but the prices are different. The first one will cost you £1000 from your local garage, and it comes with full guarantee. That is, if it breaks down, they will repair it. The second car is being offered as a private sale for only £600, but of course, if it breaks down, the repairs are your responsibility. If it does go wrong, you can choose either to have it repaired or to resell it.

Before we go through and solve this problem, remember that this is simply an example of how the method is applied. If there is anything which you do not understand as you go through it, don't ponder too deeply over it. Go through to the finish, and then move on to the main part of the Teaching Program.

2.2 Laying out the Tree

We are now going to use the computer screen to draw an example of a decision tree. First load the teaching program, and select the **Worked Example** option from the menu. When the computer is ready, follow the text and press the keys in the sequence shown to build up the tree, one step at a time.

Start the program by typing the letters **G O** on the keyboard. The first thing which the computer draws on the screen is a square box. On our diagram, the box will be the standard symbol used to represent a point in time when a decision is to be made. Initially, we can make one of two decisions, so we draw in a line representing each – press **1**. We can buy the guaranteed car, or the cheap car.

barato

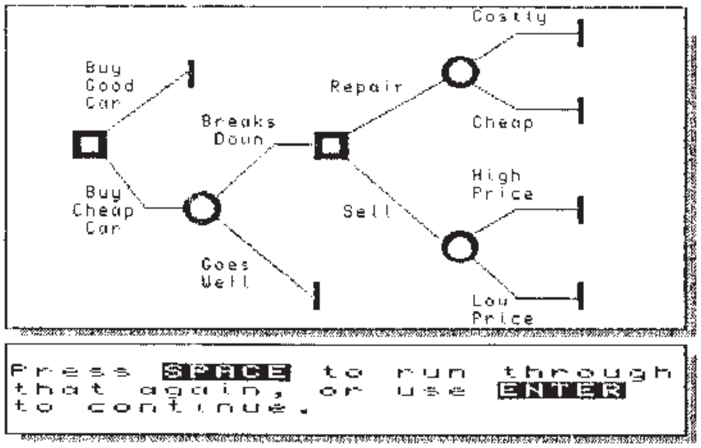
If we choose the guaranteed car, then we can assume that there will be no more to worry about, so we end the line with a bar – press 2. With the cheap car, on the other hand, there is more to consider. It may be OK, but it may break down, and if it does, it's your problem. Therefore, we invent a new symbol to represent a 'chance' event, that is, one over which we have no control – press 3, and you will see a circle. Either it will be no problem, or it will break down – press 4. If it doesn't break down, there is no more to worry about, and we can end that line with a bar. But if it breaks down, we have another decision to make – press 5.

We can now choose between getting it repaired and selling it, so we can add two more lines to the picture – press 6. To make the problem simple, we will assume that we don't know in advance how much the car will cost to repair or how much we can sell it for. These are two more chances we will have to accept – press 7.

The repairs could either be costly or cheap – press 8 – and we could either get a high or low price if we sell – press 9. Now we assume that if we have to get the car fixed, it will be OK from then onward, but if we decide to sell it, we will simply be able to replace it with the £1000 car which we were offered in the first place, so we can end all the lines with a bar – press 0.

Well, that's step one completed. We have worked out the sequence of events and drawn a diagram to represent it. For obvious reasons, this diagram is called a **DECISION TREE**. Each of the **DECISION** and **CHANCE** points on the tree is known as a **NODE**, whilst each of the lines which describes an event is called a **BRANCH**

If you are a little uncertain about the procedure up to this point, the computer offers you the facility to rerun the process of laying out the tree. Otherwise, leave the computer and read on:



2.3 Adding the Information

For many complex decisions, the process of drawing the tree itself will help a great deal in resolving the problem. But to reach a conclusion, we must find a way to value each decision. In the used car example, the normal approach would be to find the lowest cost solution, and that is what we will do next. This is our 'Decision Criterion' – we want to find the cheapest answer.

If you look at the tree we have drawn, you will see that it has six 'endings', which represent the six possible final outcomes whch can arise from the decisions we have chosen to make. You can trace out on the tree how each outcome could occur as follows:

1 We buy the guaranteed car, and there is no more to worry about;

or

2 We buy the cheap car which turns out to go well, and there is no more to worry about;

or

3 We buy the cheap car, it breaks down, we repair it and it costs a lot of money;

or

4 We buy the cheap car, it breaks down and we have it repaired for a low price;

or

5 The cheap car breaks down and we sell it for a profit, putting the money towards buying the guaranteed car;

or finally

6 The cheap car breaks down, we lose money on selling it and we buy the guaranteed car.

We must now perform step two of the process, working out how much each outcome will cost us. We lay out all the individual costs involved as follows:

Buying the guaranteed car	£1000
Buying the cheap car	£ 600
Expensive car repairs cost	£1000
Inexpensive car repairs cost	£ 300
High resale price of car	£ 800
Low resale price of car	£ 400

You can see that some of these figures represent costs which we cannot 'know' in advance. We have had to make the best subjective estimates we can achieve. Although this may sound like a difficult problem, in most situations the people involved usually have a reasonably good idea of what the various outcomes may cost or what profits they may generate. If you are not certain, it is a simple matter to rework the problem with different costs to see how much that changes things.

These figures can be combined to find out how much each outcome will cost us. For instance, the expensive repair branch will have cost us £600 for the car plus £1000 for repairs, a total of £1600. The high price sale branch will have cost us £600 for the cheap car, then a gain of £800 from selling it and a payment of £1000 for the good car, a total cost of £800. All the other branches have costs which can be worked out in the same way. Try them for yourself and then press 1 for the computer to display the correct figures. You will notice that they are shown as negative amounts. This is because they are 'costs'. Positive values on the tree are used to represent revenues, that is money earned or received.

2.4 Probabilities

Step three involves determining one more piece of information before we solve the tree. You know that there are three 'chance' nodes on the tree, depicted by circles. These are the places where we have no control over what will happen next, but we can make a good guess at which outcome is more likely at each node. For instance, we may think that the cheap car is more likely to break down than to go well. Let us say that there is a 70% chance of breakdown, which means there is only a 30% chance of it going well (remember that the two percentages must add up to 100%).

Likewise, we think that there is a 60% chance of repairing it cheaply if it does break down, and because we know that you are a good salesman, there is also a 60% chance of you being able to sell it for a higher price than you paid for it.

Before we use these probabilities, we convert them into decimal values. This is because the convention for probabilities is that they are represented by numbers in the range 0 to 1. For instance, 70% becomes 0.7, 40% becomes 0.4, and so on. In this way, 100% is represented as 1, therefore the rule that percentages must add to 100% becomes 'Probabilities must add up to 1'. So, press 2 to display the probabilities on the tree. You can see that the probabilities at each chance node add up to 1. As in the case of some of the cost figures which we used earlier, these probabilities represent our best guesses of what might occur.

2.5 Finding the Solution

Now we have enough information to perform step four, selecting the best decision, but this is the difficult step for the novice. Here we will just show you quickly HOW it is done. The program will explain WHY we do it this way in a section further along. To arrive at the solution, we start at the right hand end of the screen, and calculate a value for each chance and decision node in a process known as the 'roll-back'. There are two rules, one for decision nodes and one for chance nodes.

Rule 1 – Chance nodes
To calculate the value of a chance node, multiply the value of each of the nodes immediately following by the probability of the event leading to it, and add the resulting figures together. e.g., consider the costly/cheap repair chance node. The two following nodes are the ends, with values of −£1600 and −£900 and probabilities of 40% and 60%. The value of the node is therefore:

$$-£1600 \times 40\% \text{ plus } -£900 \times 60\%$$

$$= -£640 - £540 = -£1180$$

– press **3** to display this result on the screen.

The high/low resale price chance can likewise be evaluated as follows:

$$-£800 \times 60\% \text{ plus } -£1200 \times 40\%$$

$$\times -£480 - £480 \times -£960$$

–press **4** to display this result as well.

Rule 2 – Decision nodes
The value of a decision node is equal to the best value of all the following nodes. The events leading to nodes of lesser values are eliminated as unsatisfactory options. e.g., the sell/repair decision can take the value of either −£1180 or −£960 from the following nodes. As these are costs in our example, the figures are negative and the best value is the lesser negative one, −£960. Therefore, the node has a value of −£960, and the 'repair' option is eliminated. That is, if we were ever faced with this choice, we should always choose to sell. Press 5 to display this value. Note that the computer also draws a 'bar' across the repair option, as this has now been deleted.

There are now only two nodes left to evalute; the chance of breakdown, and the initial buying decision. The chance node has a value of:

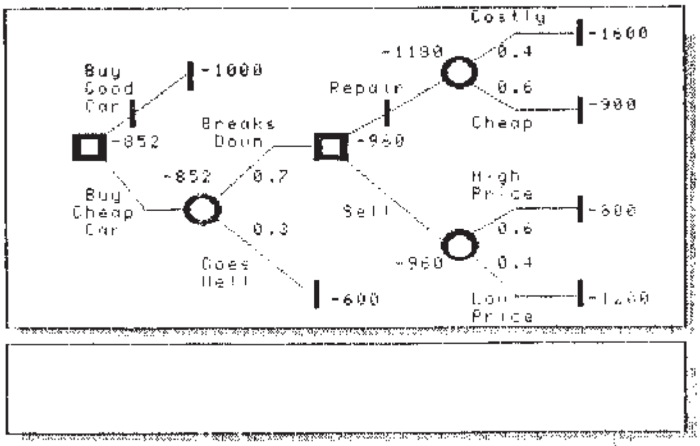
$$-£960 \times 70\% \text{ plus } -£600 \times 30\%$$

$$= -£672 - £180 = -£852$$

– Press ↵ to display this.

And now you can see that the first decision can be given the value of either –£1000 (guaranteed car) or –£852 (cheap car). Therefore the cheap car option is selected, with a value of –£852, and the guaranteed car alternative is eliminated. Press / to display this final result.

So, the tree tells us to buy the cheap car, and sell it again if it breaks down – it sounds like quite a reasonable answer to me!



2.6 What Now?

Well, if you followed the way in which we found a solution to the example, you should have now just about enough knowledge to try to solve your own trees. If, on the other hand, you are still worried, you need not be. This program goes on to explain each of the elements of decision analysis in more detail, and provides practice routines so that you can become completely familiar with the process. If you are ready to continue learning, select the option on the screen to move on to another module, or you may like to run through this chapter again – it's up to you!

If you do feel bold enough to try a tree of your own, turn to Chapter 12 and follow the instructions to use the Applications Program. We suggest that you start by using the example problem we have just been through, and then try changing it around, perhaps by adding the 'what if' alternatives you may feel appropriate. To make matters simpler for you, you will find that this, together with all the other examples used in the text, is summarised in Appendix 1 at the end of the manual. If you try the example we have been using, and find it a little too difficult, you can always come back to this point and continue from here.

Chapter 3

Decision Structure

3.1 Nodes & Branches

The example which we presented in Chapter 1 showed you how we can draw a 'tree' to represent the series of decision points and chance events which make up a complex decision problem. Let us now think through the way in which the structure was formed. Type D S to display the example again. First of all, we recognised an initial point where we had a choice of action. We called this point a 'Decision Node'. From this node, led two branches representing the alternative courses of action. One branch simply came to an end (terminated) because nothing further resulted from the action. The action represented by the other branch, however, led to the possibility of alternative outcomes; breakdown or no breakdown. These outcomes led in turn to another decision, or to no further action. In this way, the tree was constructed of five basic elements; three types of node and two types of branch. The three node types are represented by circles, squares and bars whilst the branch types depend upon the types of nodes they spring from;

ACTION branches originate from **DECISION** nodes.

OUTCOME branches originate from **CHANCE** nodes.

You can see the difference in the example on the computer screen. The computer will now be used to highlight the different branch types for you. Press 1 and follow the instructions at the bottom of the screen.

3.2 Choice & Chance

You will recognise that ACTIONS are the things that you can choose to do, whilst OUTCOMES are things that you cannot choose. Notice, however, that you may be able to influence some OUTCOMES. Your own actions can make certain outcomes more or less likely. For instance, the action of wearing a raincoat will not change the chance that it will rain, but it will have an effect on the chance that you will get wet.

Here is a simple exercise to test your understanding so far. The computer will draw a new decision tree about choosing whether to use the M4 or the M40 to drive out of London in the rush hour. It will then highlight various parts of the tree by flashing them on and off. You must decide whether the flashing element is a CHANCE NODE, a DECISION NODE, an ACTION or an OUTCOME. Tell the computer your answer by pressing C, D, A or O respectively. But first, press 2 to display the tree.

3.3 Review Problem

Now you can try drawing a tree of your own. Here is the simple problem:

> You are setting up a new computer showroom. One of the computer manufacturers, Microfruit plc, has offered you an agency for their range of two computers, the Avocado and the Banana. (We'll call them A and B from now on), but their proposal is a complex one structured to test your selling skills. You can choose to accept one type A *or* one type B computer only. If you sell it within a certain time limit, they will offer you one of the other type to sell. But if you fail, they will take the computer back and refuse to deal with you any more. On the other hand, if you sell the second one as well, they will make you a dealer. You are a little worried about the costs involved, and so you may choose to decline the offer immediately, or perhaps decline part way through. If you persevere and succeed, then you will automatically take up the dealership, and make an attractive profit.

Well, that is the decision which you have to structure. When you start the next section of the program, it will ask you what to do by showing you a series of alternatives and allowing you to make a choice. This list of choices is in the form of a 'menu' at the bottom left of the screen, smaller but similar to the one you have already used to select this module. It works in exactly the same way as before. You will be asked to make a whole series of selections until finally the tree structure is complete. When you are ready, just press ↵ to start work.

Chapter 4

Inserting The Values

4.1 Calculating the Payoffs

As we mentioned in the Introduction, the Decision Analysis method works on the basis of each of the outcomes having some measurable value. When you use the method, you compare these values and select the series of decisions which leads to the best result.

Once you have drawn a tree, it will have a number of endings, and you have to work out a value for each one. You do this by tracing your way through the tree from the starting decision, along the branches to the particular end of the tree which you want to value. The actions and outcomes along the way will have costs and values. If you add them all up as you go, you will have the value or cost of reaching the final result. This final value for each branch end is called its **PAYOFF**. We will now return to the used car example to demonstrate this more clearly. Remember that the figures involved were as follows:

Purchase of the Good Car	£1000
Purchase of the Cheap Car	£ 600
Costly Repairs	£1000
Cheap Repairs	£ 300
Low resale price and purchase of Good Car	£ 600
High resale price and purchase of the Good Car	£ 200

The computer will be used to redisplay the tree and calculate each payoff in turn, showing how it is done. The calculations will appear at the bottom of the screen. Press I V to continue with this section.

To Calculate the Payoffs.

1. You must calculate the payoff for every terminated branch.
2. The payoff is the total amount that that particular end result would earn us or cost us. Remember that costs are negative.
3. Calculate the payoff by adding up the costs and values of all the branches that lead to that terminated branch.

4.2 Review Problem

It's now time to try an example of your own, so let us have another look at the Microfruit Dealer problem.

In addition to the structure of the tree which you have already resolved, you will need to know the costs and profits of all the actions and outcomes. Well, here they are:

Cost of advertising the Avocado	£ 400
Cost of advertising the Banana	£ 500
Profit from selling the Avocado	£ 200
Profit from selling the Banana	£1000
Net Profit once dealership is acquired	£5000

Remember, if you choose to attempt to sell one of the computers, you will have to pay out the advertising costs associated with it whether you sell it or not. Profits are always considered as positive numbers, whilst costs are negative, (both profits and costs are referred to as values).

When you proceed with the program, the procedure will be as follows:

1 The computer will identify a payoff point with a flashing question mark, and will ask you to select the events leading to it.

2 You will then be able to choose the events, one at a time, by following the instructions at the bottom of the screen. As you choose each event, it will ask for its value, which you can find from the list in the text. Don't forget that costs are negative and earnings

are positive, and don't forget that some events may have zero values.

3 When you have told the computer that there are no more events leading to that payoff, it will calculate the answer from the figures you have given it.

4 Steps 1 to 3 must be repeated until all payoffs are calculated.

Now press 1 to start the program. If you make a mistake entering a value, you can use the CTRL and the ← arrow key and try again.

Chapter 5

Probabilities

5.1 Adding up the Odds

Each chance node on the tree heralds a series of possible **OUTCOMES**, with each outcome having a particular likelihood or 'probability' of occurring. For instance, if we decide not to wear a raincoat, the chance outcomes are that it will or will not rain. If we felt that it was certainly going to rain, we could express this by saying that there is a 100% chance of rain. – 100% represents certainty. On the other hand, we may decide that there is a 90% chance that it will rain, and a 10% chance that it will not rain.

If we once again reduce our forecast of rain to a 60% chance, then, of course, we are also implying that the chance that it will not rain increases from 10% to 40%. What we are saying here is that the total of the probabilities of all the outcomes must add up to 100%. If the probabilities do not add up to 100% then either the probabilities are wrong, or we have not included all the possible outcomes. When we draw a chance node on a decision tree, the probabilities of the events leading from it MUST add up to 100% because ALL possible outcomes must be included.

Using the rainy day example again, we could list the following possibilities:

1 It will only rain when I am on my way to work – chance of 10%

2 It will only rain when I am on my way home – chance of 20%

3 It will not rain at all today – chance of 10%

So far, this list of outcomes could be correct, but the probabilities do not add up to 100% because there are some other possible outcomes:

4 It will rain on my way to work AND on my way home – chance of 30%

5 It will rain, but not when I am travelling to or from work – chance of 30%

Now they add up to 100%, so there cannot be any more possible outcomes. For instance, we could feel that there was a 5% chance that it would be raining at 3.00 p.m., when I am still at work. This cannot be an extra possible outcome because we already have probabilities adding up to 100%. In fact, if we look at the list, we can see that this possibility is already covered by alternative 5, and therefore need not be added.

It is possible to simplify the range of outcomes by combining them and adding their probabilities together. In the raincoat example, I am only concerned with whether or not it will rain when I am outside, that is, when I am on my way to or from work. So we can add all the outcomes where it does rain when I am out and all the outcomes where it doesn't, thus reducing the problem to only two outcomes as follows:

Take
1 Rains on my way to work – chance of 10%

2 Rains on my way home – chance of 20%
and
4 Rains in both directions – chance of 30%

add these together to get:

Rains when I am going to or from work – chance of 60%

Similarly
3 Doesn't rain at all – chance of 10%
and
5 Rains, but not when I am out – chance of 30%

add together to get:

No rain when I am going to or from work – chance of 40%

Both ways of considering the outcomes are correct; whether there are five or more outcomes, or only two, as long as they add up to 100%. The important thing is to divide up the outcomes in a way which is relevant to your problem.

5.2 Probabilities & Percentages

Up to this stage, we have discussed probabilities in terms of percentages, because most people think of them in this way in day to day life. However, there is a mathematical convention that probabilities are expressed as numbers in the range 0 to 1. An event with a probability of 0 has no chance of occurring, whilst an event with a probability of 1 is certain to occur. The method for changing from percentage values to decimal values is simple; just write the percentage value after a decimal point, remembering to put a zero in front of percentages less that 10. e.g. 70% becomes 0.70, which is the same as 0.7, because zeros on the end of decimals have no effect; and 7% is changed to 07% and becomes 0.07.

Let us return to the Computer Agency problem and insert the probabilities; We have done some homework on the risks involved, and we have reached some conclusions. We think that the Avocado will be a popular model, and we feel that there is a 60% chance (probability of 0.6) of selling it by the deadline. Obviously, on the other hand, there is a 40% chance (probability of 0.4) of not selling it, and you will have to give it back. The Banana, on the other hand, is a much more expensive unit, so there is only a 20% chance (probability of 0.2) of selling it in time. What does that make the probability of NOT selling it?

Press P R to continue with this section. Follow the instructions on the screen to select each outcome in turn, and enter its probability.

To Convert Percentages to Probabilities.

1. A decimal probability is like a percentage with a decimal point in front of it.

   e.g. 65% = .65, 32% = .32, and so on.

   BUT

2. For small percentages less than 10%, add a zero in front first.

   e.g. 6% = .06, 3% = .03, and so on.

3. For decimal percentages, just ignore the old decimal point.

   e.g. 38.6% = .385, 94.67% = .9467, 3.25 = 03.25% = .0325

Chapter 6

Expected Value

6.1 The Key Concept

Understanding the idea of 'Expected Value' is critical to the constructive use of Decision Analysis techniques. We can define the Expected Value of a situation as the average value it would have if it were to be repeated many times. In most situations, values in decision making are expressed in monetary terms, and so are called 'Expected Monetary Values' or EMV for short.

6.2 EMV of Chance Events

Let us consider an example:

> A novice card sharp has a normal pack of 52 cards – no jokers in it. He is going to offer you a proposal; You cut the pack 100 times. Every time you get a black card, he pays you £10, but every time you draw a red card, you have to pay him £6. Do you accept his offer?

Well, I think you can tell that this is a good game from your point of view. Half of the cards are black, and half are red, so you can expect to draw about 50 of each. You will win 50 × £10, and have to pay 50 × £6, and you don't need a computer to work out that you will then make a profit of about £200.

The Expected Monetary Value of this game is therefore £200. Now we can work out the EMV of only one cut by dividing the overall EMV by the number of cuts in the game, 100. So the EMV of one cut is £200/100 = £2. On average, you will earn £2 from each cut. This is the same as saying you have a 50% chance of wining £10 and a 50% chance of losing £6 for each cut:

$$£10 \times 50\% \text{ plus } -£6 \times 50\%$$

which is the same as:

$$£10 \times 50\% \text{ minus } £6 \times 50\%$$

$$= £5 \text{ minus } £3 = £2$$

To calculate the EMV of a chance event, simply multiply the value of each outcome by its probability and then add them together. Don't forget that, as in our example, some values are negative (we usually call negative values COSTS) and if they are, they must be subtracted instead.

This concept can be transferred to the Decision Tree as follows: the EMV of a chance node is calculated by multiplying the EMV of each of the nodes immediately following by the probability of it occurring, and adding the results together.

6.3 EMV of Decisions

Now, I am afraid that our novice card sharp has been listening in to our discussion, and has figured out that his proposal is not such a good idea from his point of view, so he has changed it:

> What he now offers is this; he will lay a black card and a red card face up on the table and ask you to choose one of the cards. He tells you that if you choose a red card, he will pay you £6, but if you choose a black card, you must pay him £10. He reckons that there is a 50% chance that you will pick either card, so on average he will win £2! Can you see the obvious flaw in his devious plan?

Well, you and I know that we will not leave our selection to chance, you will pick the red card every time, and he will have to pay you £6 every time. The difference is that this is not a chance node, but a decision node. You can decide what will happen. The EMV is £6 because you will always choose to take the higher payoff.

Hence, the EMV of a decision is the highest of the values of the alternatives available. Again, this approach can be transferred to the Decision Tree; the EMV of a decision node is selected as the highest of the EMVs of the immediately following nodes. The decision actions leading to nodes with lower EMVs are permanently discarded.

To Calculate the EMV of a Node.

The EMV of a CHANCE node is the total of the EMVs of all the nodes which follow it, each multiplied by the probability on the branch which leads to it.

The EMV of a DECISION node is the highest of the EMVs of the nodes which follow it.

The EMV of a TERMINAL node is the same as its PAYOFF.

Finally, return to the program and press E V and follow the instructions to run through some exercises on calculating the EMV of chance and decision nodes. The computer will generate a series of at least ten exercises, starting with simple ones and getting more difficult as you go. There will be a mixture of decision and chance nodes to solve. Decision nodes just require you to choose a single value, but a calculation is required for a chance node. If a calculation is needed, you just have to supply the figures, and the computer does the arithmetic for you. Remember that on a computer keyboard, you use the * symbol to multiply.

Chapter 7

The Roll-Back

7.1 Applying EMV

Whilst EMV is the key concept in the use of Decision Analysis, the actual technique which produces the answer is called the 'Roll-Back'. The name comes from the way we start at the end of the tree and work backwards through it to get to the answer. Simply start at the ends of the tree and work out the expected value of each node in turn until, finally, we have the EMV of the very first decision node. Then you have your answer; the first decision you make is the one with the highest EMV. After that, you follow your progress through the tree and continue by making each subsequent decision by selecting the highest EMV.

Now that you know from the last section how to calculate EMVs, you can go straight on and 'Roll-Back' your first tree. You can see why we must start at the end and work backwards; because the EMV of a node depends upon the EMVs of the following nodes, we have to calculate them first.

We will now use the original Used Car example as the first exercise. Press **R B** to continue with this module, and begin to work through it. As in the previous chapter, you don't need to do the calculation in full for the chance nodes – just enter your workings, such as '1000*0.3 – 200*0.7'.

7.2 Another Review Problem

It is a very straightforward procedure – just try rolling back one more tree. We'll use the Computer Agency example this time. Press 1 when you are ready.

The Steps So Far.

1. Draw a diagram of the sequence of decisions and chance events which form the problem.
2. Calculate the payoff for each of the terminated branches.
3. Decide what the probabilities are for all of the change outcomes.
4. Working from the ends back to the beginning, calculate the EMV of every node on the tree.
5. Choose the decisions which lead to the highest EMV nodes.

Congratulations. You have now acquired the basic skills required to construct a decision tree. Move on to the next chapter, and we will present some more advanced techniques. Although before you continue, you may want to try a few problems on the Applications Program.

Chapter 8

Risk Profile

8.1 Review the Possibilities

The trouble with Decision Analysis is that you cannot be certain what the final outcome of your first decision will be (if you could be, then you wouldn't need to use decision analysis in the first place!). Even when you know which decision to take initially, there is still more than one possible outcome.

The greatest weakness of using Decision Trees to analyse a complex problem occurs because many people fail to take the next two steps – analysing risk, and measuring sensitivity. This is because they can represent a significant chore, once so much time has been spent achieving the first Roll-Back of the tree. Fortunately, when you have completed this learning process, you will be able to use the Applications Program to undertake these crucial steps with ease. But first, back to the method:

Consider the Used Car example; when you have eliminated the lower value alternatives, there are three possible final outcomes:

1 The cheap car doesn't break down, and all is well, costing you £600.

or

2 The car breaks down, you sell it at a loss and buy the guaranteed car, costing you £1200 altogether.

or

3 The car breaks down, you sell it at a profit and buy the guaranteed car, costing you a final figure of £800.

So, we can say that there is some risk that our decision will cost us as little as £600, or as much as £1200. Suppose that you don't have £1200, but only £1000, then this risk may not be a very pleasant prospect. If you cannot afford to take the risk, you may have to choose another option with a poorer EMV, with no risk of it costing more than £1000. In the Used Car case, this would mean buying the guaranteed car. On the other hand, if you can afford to take the risk, then it is more likely that you would be better off with the cheap car.

This is what checking the Risk Profile of the Decision means, and it is an important step which you must always take in using decision analysis, to be certain that there are no hidden risks which you would be unhappy to accept.

8.2 Measure the Risk

We can actually go a little further than this and work out how likely each possible outcome is once we have selected the best sequence of decisions. Just follow these simple steps:

1. Look through your tree very carefully and write down all the possible final outcomes which remain after you have selected the best decisions.
2. For the first possible outcome, trace the path back to the starting decision node. Write down the probability on each of the chance outcomes which lie on that path.
3. Multiply all the probabilities together. The answer you get is the probability of that final outcome occurring.
4. Repeat steps 2 and 3 for all the other possible outcomes.
5. As a double check, just add all the calculated probabilities of final outcomes together. If you have worked through correctly, they will add to 1 because they represent the sum of all possible outcomes.

Press **R P** on the keyboard, and the program will demonstrate how to apply this to the used car example.

8.3 Final Check

We can summarise the risks of buying the cheap car as follows:

1 0.3 probability that it doesn't break down, and all is well, costing you £600.

2 0.28 probability that it breaks down, you sell it at a loss and buy the guaranteed car, costing you £1200 altogether.

3 0.42 probability that it breaks down, you sell it at a profit and buy the guaranteed car, costing you a total of £800.

As a final check, make sure that the probabilities add up to 1:

$$0.3 + 0.28 + 0.42 = 1.0$$

Now press 1 and try out the process on the Computer Agency decision. Use the highlight to select each possible final outcome, then press the SPACE bar and feed in the percentages which lie on the path of that outcome.

Chapter 9

Sensitivity

9.1 Change the Numbers

The great advantage of using a tree to solve a decision problem is that it forces you to structure your view of the problem. But what you must not lose sight of is the fact that the solution which the tree provides is only as good as the data YOU feed in. Don't be fooled by your own numbers just because you have processed them in a sophisticated way.

Often you will find that the difference in EMVs between two alternative decisions is only a small figure. In those cases, it is essential that you manipulate the numbers to find out how much they need to be changed to alter the decision. This is an easy task when you're using the Applications Program supplied in this package, but it can be very tiresome if you are solving the tree manually. The process of changing the numbers to see what happens is called a 'Sensitivity Analysis' because you are finding out how sensitive the solution is to the data you have provided.

To demonstrate this point, press S Y to redisplay the used car tree. Let us now try changing some of the values. The computer will allow you to select any probability or payoff, and permit you to change it within a reasonable range. Each change will recalculate the entire tree. You can watch the effect as it happens.

Find out which value can be changed the least amount to change the initial decision from the cheap car to the good car. You can also select the two options at the top left of the screen. 'Finish Exercise' is self explanatory. The 'Restore Values' alternative will change all of the figures back to their original figures – very useful if you want to test one factor at a time.

Always Calculate the Risk Profile.

Remember the steps involved:

1. When the tree has been rolled back, eliminate all of the payoffs which will never be selected.
2. For each of the remaining payoffs, trace along the sequence of events which leads to it, and list the probabilities encountered.
3. Multiply this sequence of probabilities together for each payoff, and this is the probability of that payoff occurring.

9.2 Applying Judgement

The second point to bear in mind when considering a solution which depends on only a very small difference between EMVs is the non quantifiable or non financial component of the decision. Suppose you are using the tree to decide whether to close down Microfruit PLC. You have input all the numbers, including profits, losses, redundancy pay, and so on, and the tree says 'CLOSE DOWN' because that has an EMV of £2,000,000, compared with £1,990,000 if you stay open. When you consider the social and public relations effects of firing the workforce of 500 people, you may think that this outweighs the small difference in EMVs.

In summary:

- Always check the sensitivity of the answer to changes in the data.
- Always consider the qualitative issues.
- Always produce a risk profile.

and, most important of all:

- Always interpret the answer using common sense.

Chapter 10

Value of Information

10.1 A Typical Problem

When you are working through a complex decision model, you will often find yourself wishing that you had some more information to help you make your decision. One thing that you can work out from the tree is how much some extra information might be worth, in terms of an increase in the value of the decision. An example will probably make this point clearer:

> Suppose that you have the opportunity to buy 1000 Microfruit shares. You know that they are introducing a new portable computer, the Currant, but that it may be running behind schedule. The Microfruit watchers say that there is a 70% chance that the new computer will be late. If it is late, the shares will fall from £2.30 to £1.50, but if it is on time, they will rise to £6.00.

Press V I to draw this simple tree.

As you can see, the 'buy' option has a positive EMV of £550, so, providing you can live with the risk of losing £800, you should go ahead.

10.2 Perfect Information

Just before you go and see your broker, you meet a Microfruit technician in the pub who knows whether or not the Currant is going to be late. He is willing to advise you providing you can agree a fee for his knowledge. How much is the information worth?

Well, there is a 70% chance that he will tell you that the Currant is late, in which case you will not make the investment and you will win or lose nothing. On the other hand, there is a 30% chance that he will tell you that it is on time and in that case you will rush around to your brokers immediately, knowing that you will make a profit of £3700. So, his information will change the EMV to 0.7 times zero plus 0.3 times £3700, which is £1110, £560 more than without the information. Therefore, providing the information costs less than £560, you will be better off if you buy it. This is because the information eliminates the risk of losing any money.

The increase in EMV brought about by knowing what is going to happen is called the Expected Value of Perfect Information (EVPI for short). You must remember, however, that finding someone who knows what is going to happen does not change the probabilities of the event. The technician does not change the chance that the Currant will be late, it is just that from his point of view, the event has already happened.

10.3 Sample Information

Now the chances of being able to buy perfect information are very slight, but there are often ways of obtaining some better information at a price. For instance, perhaps you know of a Microfruit analyst who has a reputation for making much better predictions than most of the others, and who sells his services for a fee. You now have the option of securing his services before you make up your mind. Therefore we can now incorporate this additional decision into the tree. Press 1.

Doesn't one extra step make a big difference to the size of the tree? Now we have some extra chance nodes and outcomes, and so we need some more probabilities. The only extra information we have is that the analyst has an 80% success rate with his predictions, and we must combine this with our previous information that there is a 70% chance of the Currant being late. Here we require a particularly fancy bit of arithmetic based upon a concept known as 'Bayes Theorem'. Watch carefully.

What we need to know first is the chance that the analyst's advice will be 'It's Late', and the chance that it will be 'It's on Time'. The best way to work this out is on a diagram, so press 2 and the computer will act as our drawing board. First, we have drawn a box to represent the 'future'. We can divide it vertically to represent the chance of Currant being late, and the chance of it being on time. Remember that the proportions are 0.7 to 0.3 – press 3. Now we can divide it horizontally for the chances of the analyst being right and wrong in the proportions 0.8 to 0.2 – press 4. Next, we consider what each part of the box represents:

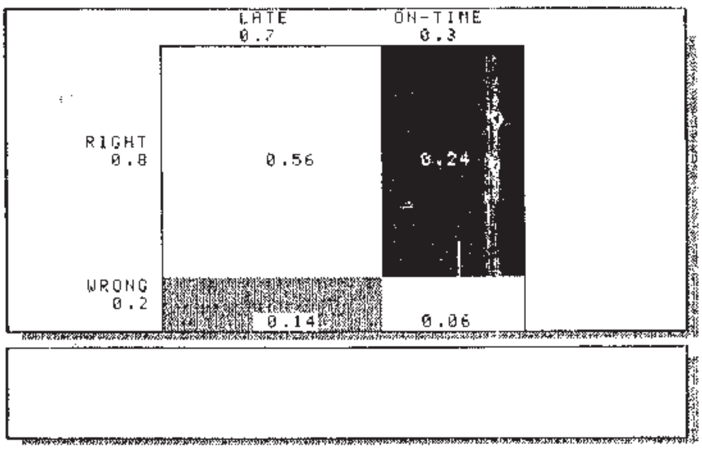
1 The top left hand section represents the analyst being right in his forecast and the Currant being late, so this occurs when the analyst says that the Currant will be LATE and it is.

2 Top right is analyst correct and Currant on time, so the analyst must correctly predict that the Currant will be ON TIME.

3 The bottom left signifies analyst wrong and Currant late, so this occurs when the analyst says that the Currant is ON TIME when in fact it is not.

4 Likewise, bottom right is analyst wrong and Currant on time, so in this case, the analyst must say that the Currant is LATE when it is not.

The area of each part of the box is proportional to the chance that the event it represents will occur. It can be calculated just as in geometry by multiplying its width by its depth. For instance, the chance of the analyst being right and the Currant being late is 0.8 times 0.7, which is 0.56. You can watch the computer do all the sums by pressing 5.



Now, for the tree we need to know the chance of the analyst saying that Currant will be on time and the chance that he will say it will be late. That's easy – just add the appropriate probabilities together:

A He says 'ON TIME' 0.14 (bottom left) plus 0.24 (top right), total 0.38.

B He says 'LATE' 0.56 (top left) plus 0.06 (bottom right), total 0.62.

Go back to the tree by pressing 6 and we will add these probabilities. Remember that we asked the analyst whether the Currant will be late. Thus 'Yes' means that he says that it will be late, and 'No' that it will be on time.

If you trace the path along the bottom of the screen, the next chance node you reach is the point where we see whether the shares rise or fall (i.e. whether the Currant is on time or late), following the analyst's forecast that the Currant will be late. After that forecast, what are the chances that he is right or wrong? From the box diagram, we know that our estimate of his 'LATE' forecast was based on him saying 'LATE' and being right (0.56), plus him saying 'LATE' and being wrong (0.06), totalling 0.62. Now we just need to convert the two parts into proportions of the total, 0.62, as follows:

$$0.56 \text{ becomes } \frac{0.56}{0.62} = 0.9$$

$$0.06 \text{ becomes } \frac{0.06}{0.62} = 0.1$$

(These figures are rounded up, because there is no point in being any more accurate in this type of decision tree.)

Therefore, once he has forecast that the Currant will be 'LATE', the analyst has a 0.9 probability of being right and a 0.1 probability of being wrong. Press 7 to enter these figures on the tree.

Similarly for the analyst's 'ON TIME' forecast, we perform the same calculations:

Analyst correct:

$$0.24 \text{ becomes } \frac{0.24}{0.38} = 0.63$$

Analyst wrong:

$$0.14 \text{ becomes } \frac{0.14}{0.38} = 0.37$$

– and enter them on the tree by pressing **8**. Finally, we need to insert the payoffs for the extra branches. Press **9** to do that. As you can see, the payoffs are no different from those we used on the very first Rise and Fall branches of the tree. The computer is now waiting for you to 'Roll-Back' the tree, just as you learned to do in section 8.5. Off you go.

Now, look what's happened! The EMV has risen from £550 to £773, and so the analyst's advice is worth something to us – the difference between £550 and £773, £223. Therefore, if we can buy his advice for less than £223, we should take it! That figure is called the Expected Value of Sample Information, or EVSI for short, and should not be confused with EVPI which we reviewed earlier. Remember that the EVPI was much higher at £560 in this case.

The more accurate the sample information becomes, the closer EVSI gets to EVPI, but it will never get larger than EVPI. This is a useful point to remember because, as you can see from the work we have done, EVPI is much easier to calculate than EVSI. If you know how much the information is going to cost you, always work out the EVPI first to make sure that the cost is less than that figure, before you begin the lengthy process of calculating EVSI.

10.4 Summary

Remember the difference between EVPI and EVSI:

EVPI, *Expected Value of Perfect Information* is the increase in EMV that can be achieved if you can get a 100% forecast of what the outcome of a chance event will be.

EVSI, *Expected Value of Sample Information* is the increase in EMV that can be achieved if you can use an experiment, sample or expert to gain a more accurate forecast of what the outcome of a chance event might be.

To make sure that you can handle EVSI, here are some revision exercises based upon the Microfruit Share example, but with the percentages changed. You can run as many or as few of these exercises as you wish. Just press **0** to start.

Calculating EVSI.

1. Draw the simple decision tree without showing the option of obtaining additional information, and perform the Roll-Back.
2. Add the new option of seeking the additional information.
3. Make an assessment of the reliability of the extra information.
4. Use the probability box to calculate the probabilities to add to the tree.
5. Roll-Back the tree in the usual way, and the change in the EMV of the initial node is the EVSI.

Chapter 11

More Practice

Finally, before you attempt to apply QL. **Decision Maker** to your own problems, it would be wise to run through a few sample problems just to check your skill. We have two series of problems for you. The first set is a series of Roll-Back exercises in which the computer will generate trees with payoffs and probabilities marked in. You can do as many as you like, and the computer will always give you a hand if you get stuck.

The second series of problems consists of two decision case studies. You will find them set out in Appendix 1, sections A1.4 and A1.5. You will need to use the Applications Program to work out the solutions for yourself, and this will mean reading through Chapter 12 to familiarise yourself with it. When you are satisfied with your results, you should save your trees, and load our answers into the Applications Program to see how we handled the problems – they are filed on the Applications Program cartridge. Good luck, and press M P to proceed with the first series of exercises.

Chapter 12

Applications

12.1 Starting the Program

QL. Decision Maker is a powerful and unique program. Although we have made the software easy to use and the instructions clear, we recommend that you familiarise yourself thoroughly with both in order to exploit the full power and facilities of **QL. Decision Maker.** Please refer to Appendix 2 for instructions on how to load the program. The two data files, 'swedish' and 'concert' referred to in Chapter 11 of the Teaching Program are contained on the Applications Program cartridge.

When the program has loaded, you will notice that the screen is divided into four sections; each of which is called a **window**. For the rest of the chapter these windows will be referred to by names related to their functions, as follows:

DETAIL window .... Top Left
PROMPT window .... Centre Left
FUNCTION window .... Bottom Left
GLOBAL window .... Right

The **DETAIL** window is used for the display of menus and detailed information about individual decision components. You will notice the 'Main Menu' is now displayed in it. 'Menus' are lists of options which the program is able to perform and from which you may make a selection. All the menus used in Decision Maker operate in the same way; you select your chosen option as follows:

i. Press the ↑ or ↓ arrow keys or the **SPACE** bar to move the cursor up or down the menu until the selection you want is highlighted in red.

ii. Now press the **ENTER** key and the computer will execute your choice.

As well as displaying all of the program menus, this window will show small sections, or branches, of the tree in fine detail, including their names, their values and where appropriate, their probabilities. All editing, including the initial creation of the tree, is performed in this window (see sections 12.3 and 12.4).

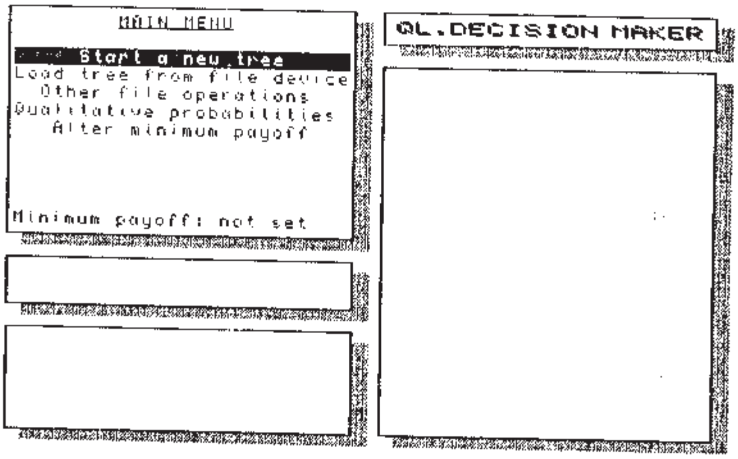
The **GLOBAL** window has only one main purpose – to display a 'global' picture or overview of the whole tree or, when the tree is very large, a portion of it (a subtree). The display shows node types, using the standard circle, square, bar notation – circles for chance events, squares for decisions and bars for branch terminations. When a tree is completed the recommended decision sequence will be shown in black with all other branches in red.

The **PROMPT** window has two functions. It is used to 'input' or enter certain types of data, for example, entering the details required to complete nodes and branches to build up the tree and identifying file devices and file names. It is also used to display prompt messages – for example, to remind you of the data input requirements or to warn of an illegal entry. The window may be used for both input and prompt functions simultaneously.

The **FUNCTION** window in the bottom left is used to show you which options are available by pressing individual function keys. These are the keys labelled F1 to F5 on the left of your QL keyboard. Options will change according to the current status of the program and only those keys which are labelled in this window will have any effect. Together, the function keys and **FUNCTION** window are used as another type of menu to help you operate the program more quickly and efficiently.

12.2 The Introductory Menu

When you first start the program, you will be presented with a menu like this:



This menu is the one you will see when you start the program or whenever there is no tree resident in the program. The **Start a New Tree** option is highlighted in red and this is the one you will usually use to begin the program – press ENTER to select it. To choose a different option, use the ↑ or ↓ arrow keys or the SPACE bar to move the red cursor to the option you want, then press ENTER.

12.3 Constructing a Tree

We suggest that when you first use the program or when constructing very complex trees, you may find it easier to define the basic structure of the tree on paper first. Don't worry too much about details, as long as you have the overall form and directions of the major branches clear in your mind before you start.

To begin, select **Start a new tree** from the Introductory Menu. The **DETAIL** window will show the initial decision node. The **PROMPT** window will contain the flashing cursor and a prompt message asking you to specify the number of branches stemming from this node. You may enter as many as five branches from each node. This should be ample in most circumstances. If it is not sufficient, refer to section 12.11. When you type your response, the number you type will appear at the cursor position. You can use the standard QL editing features (CTRL with ← and → arrow keys) to correct mistakes before pressing ENTER. If you do enter an error, do not worry as you will learn how to correct them in section 12.4. Having selected a number of branches, the computer will draw them in outline in the **DETAIL** window.

Entering Data

You must now provide the computer with detailed information about the section of tree that is being displayed. Certain types of information are optional at this stage – you do not have to enter branch names or values (although it may lead to confusion if you don't), but you must tell the program what types of node each branch leads to, and also the probability of each branch if you are editing branches from a chance node. If you do not provide a figure for the value entry, the computer will assume a zero value.

Now try experimenting. Use the ↑ and ↓ arrow keys to move the cursor up and down within the window. You will find that the message displayed in the **PROMPT** window changes depending on whether the cursor is above or below the branch. Now try using the **SHIFT** key together with the ← and → arrow keys. You will find that this also causes the message in the **PROMPT** window to change, since it moves the cursor to the data entry point to the left or right of the current one.

Move the cursor into a position under the topmost branch. The **PROMPT** window will contain a prompt asking you for the branch name in up to 17 characters. Although the program accepts a nil response and you can proceed without entering a name, we suggest that you always label branches in a logical manner to avoid confusion.

Having typed in the name, you may move the cursor in one of two ways; pressing **ENTER** will move the cursor to the next logical position, or you can move the cursor with the **SHIFT** ← and SHIFT → or ↑ and ↓ arrow keys to any position you wish.

The logical sequence the program will follow for these entries is:

1. All Names
2. All Values
3. All Probabilities
4. All Nodes

Continue to type in the branch names, and respective values and probabilities, until complete, remembering to press **ENTER** when you finish typing each entry. Stop before pressing **ENTER** for the last node when the cursor is at the bottom right node in the **DETAIL** window. Now practice using the cursor keys as before to move around the window. The ↑ and ↓ arrow keys alone and **SHIFT** ← (together) and **SHIFT** → (together) will always move the cursor whenever the **DETAIL** window is active.

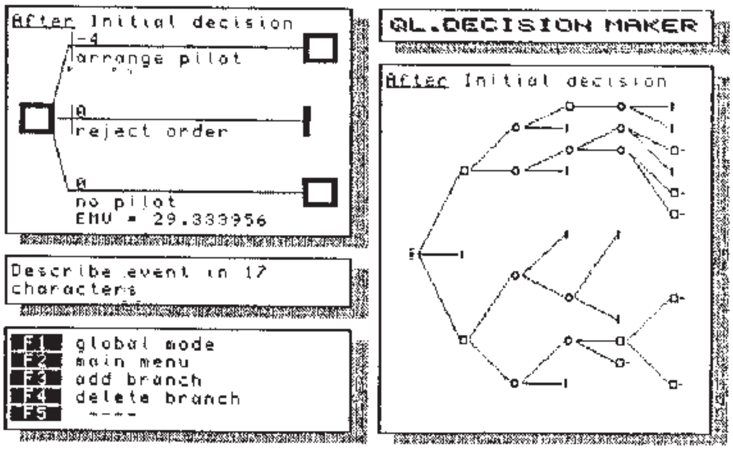
NOTE
You may now alter any of the entries you have made. Use the cursor and the QL's usual editing features to change text or figures at the required point; use **CTRL** and ↑ (together) or **CTRL** and ↓ (together) to erase whole fields; to change a node, position the cursor on the node to be altered and type in the new node.

You do not have to press **ENTER** after each alteration, just use the arrow keys to move to a different position in the window and the entry will be accepted automatically as you move. You don't have to press **ENTER** when you're typing it in the first time either, but you may find it easier if you do.

Adding and deleting branches

If you look at the **FUNCTION** window at the bottom left, you will see that four of the function keys are defined. Press **F3 Add Branch** (if your node has five branches this option will not be shown). The **DETAIL** display will be redrawn, showing the original node plus one additional blank branch at the top of the display. You can define and edit this branch as you would any other and must complete this before proceeding.

If you wish to delete a branch, use the editing keys to place the cursor on any field of the branch you wish to remove, then press **F4 Delete Branch**. This will delete the nominated branch *plus* all branches which stem from it. If this would cause the accidental erasure of substantial parts of the tree, you will be asked 'are you sure (Y/N)?'. Respond accordingly with **Y** or **N** to execute this option.



The Global Picture

If you do not wish to make any more changes move the cursor on to the bottom node. Press **ENTER** now and you will notice several effects. The global picture (on the right of the screen) will be updated – the section of tree you have just defined will appear in the **GLOBAL** window as an addition to the existing **GLOBAL** tree. The program will now find an open (incomplete) node, if one exists, and put it in the **DETAIL** window ready to be defined. This node will also be highlighted by the cursor in the **GLOBAL** window to indicate its position in the tree.

Continue using the entry and editing routines to build up your decision tree. Providing all branches in the **DETAIL** window have a probability (if applicable) and a node, you may suspend tree definition. To do this select F1 or F2 from the options in the **FUNCTION** window. You may return to the previous status by selecting **Finish Tree** from the Main Menu. This process may be repeated until you have completed the tree (i.e. all branches are terminated) or more than 149 nodes are defined. If you wish to define more than 149 nodes, refer to section 12.11 for more information.

Finding the answers

When the tree is complete with all branches terminated, the program will recognise this and perform the 'Roll-Back' calculation to determine the Expected Monetary Value (EMV) of the whole tree. The initial decision will be displayed in the **DETAIL** window and the EMV in the **PROMPT** window. With the EMV calculated, you are now able to extract detailed statistical information from any part of the tree. You will be able to find the EMV of individual decision nodes (see section 12.4), and the Expected Value of Sample Information for chance nodes (see section 12.10 and Chapter 10).

12.4 Editing

During the construction and evaluation of a tree, you may wish to return to a section of tree that you have already defined, and make changes to it. You might want to do this mid-way through tree definition, or to ask 'what if' questions of a completed tree. To do this activate the **GLOBAL** window and position the cursor on the node you wish to examine or edit. Then select the **Detail** option from the **FUNCTION** window and the node and its branches will be shown in the **DETAIL** window ready for editing. The method of editing is the same as that described in the above section on tree definition. To recalculate the tree after editing, select F2 and return to the Main Menu.

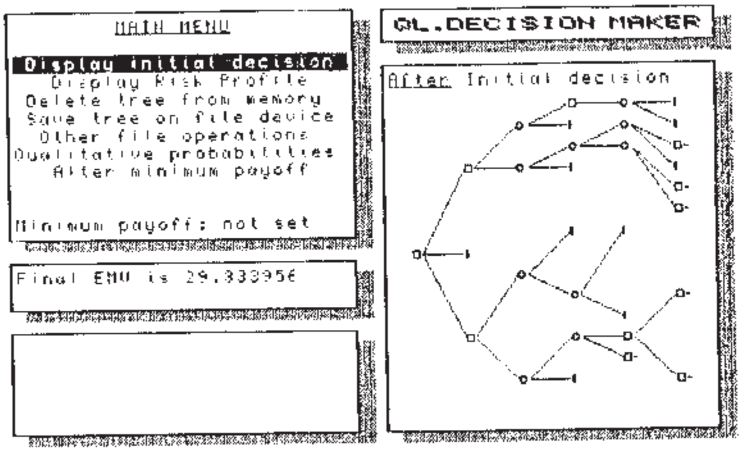
NOTE
Altering the nature of a node will cause the tree beyond that node to be deleted. The deleted section is not recoverable. In order to avoid accidental erasure, you will be asked 'Are you sure (Y/N)?'; respond accordingly with Y or N. Detailed information about how to change a node is contained in section 12.11. The editing process may be repeated indefinitely.

If your tree is complete, changing any of the figures means that the old calculations for EMV are invalidated. When you press F2 and return to the Main Menu, the program will automatically recalculate the tree and display the new EMV.

12.5 The Main Menu

The Main Menu is used to access the most common and important facilities of the program. As you begin to build your tree, access to the Main Menu will feature as an option in the **FUNCTION** window at the bottom left of the screen. When you call it up it will appear similar to the Introductory Menu, but it takes account of the fact that the tree has been partly developed. Some of the options will be the same as those already described, so although the whole Menu will be shown below, only those options which are new will be described. The **Risk Profile** and **Finish Tree** options will ony appear under certain circumstances.

If you select **Display Initial Decision**, the program will display the very first node of the tree in the **DETAIL** window at the top left. If the tree has been calculated, the selected path from the initial decision will be indicated and this will be reflected in the **GLOBAL** window. In the **DETAIL** window the non-selected paths will be barred off and in the **GLOBAL** window all non-selected paths will be coloured red. If a subtree had been displayed in the **GLOBAL** window (see section 12.10), the whole window will be redrawn to display the tree starting from the initial decision.



The **Display Risk Profile** option will only be displayed if the current tree is complete and the EMV has been calculated. It produces a display in the **DETAIL** window which shows the risk associated with each of the payoffs. This is particularly valuable information as you will be shown all of the payoffs and the respective probabilities of achieving them. You will also be offered the option of producing a hard copy print out of the Risk Profile. This is obtained by using the **Hardcopy** option of which there are full details in section 12.7. Further information on risk profiles can be found in Chapter 8 of the Text Book.

Exponential Numbers

Sometimes the results produced in the risk profile calculations can be very large or very small numbers. The short way used to display these numbers is called 'scientific notation'. A number written in scientific notation will be easily recognised because the second or third character will be an 'E'. The part of the answer written before the E is the actual value, while the number after the E defines the number of places the decimal point should be moved to the left or right. This part after the E is called the 'exponent'; move the decimal point to the right if the exponent is positive and to the left if it is negative.

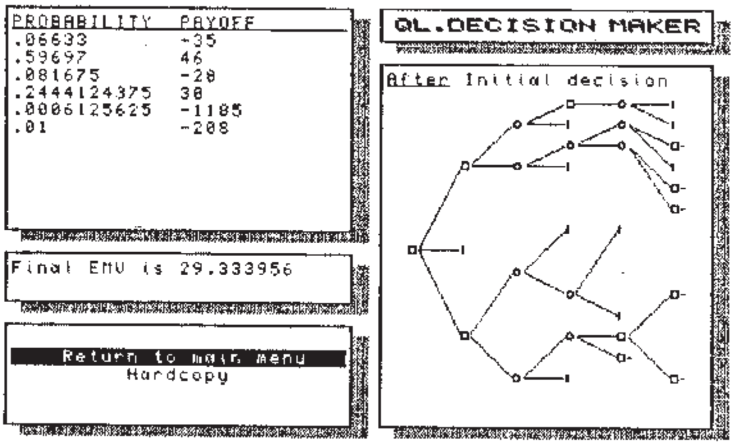
thus:

1.43E7 becomes 14,300,000
3.62E−5 becomes 0.0000362

If the number itself is negative then the sign will be in the usual place in front of the number.

thus:

−6.33E5 becomes −633,000
−7.06E−4 becomes −0.000706



If you wish to clear the tree on which you are currently working, select the **Delete Tree From Memory** option. This will allow you to begin constructing a new tree from scratch or to load one into the computer from a file device. You *must* use this option before you can load a tree file. You will be asked 'Are you sure (Y/N)?' to prevent accidental erasure of the tree on which you are working. Respond accordingly with Y or N.

It is good practice to save your work at regular intervals, say every 20 minutes, and when you finish a work session on your trees. Select **Save Tree on File Device** to do this. You will be asked for the file device name and the name of the file you wish to save (see section 12.6 for more detail). The tree need not be complete before using this option but if you are saving work regularly during a session note that fresh versions of the same file will not overwrite old versions. You must either delete the old file of the same name before saving the new, or, preferably, save different versions as different names (e.g. test1, test2) and delete the earlier versions later. Each tree file will require approximately 8 sectors of free space on a Microdrive cartridge to be saved successfully. To check the amount of space free, use the **Catalogue Tree File** option explained in section 12.6

The **Other File Operations** option is explained in section 12.6.

The **Alter Minimum Payoff** option is explained in section 12.8.

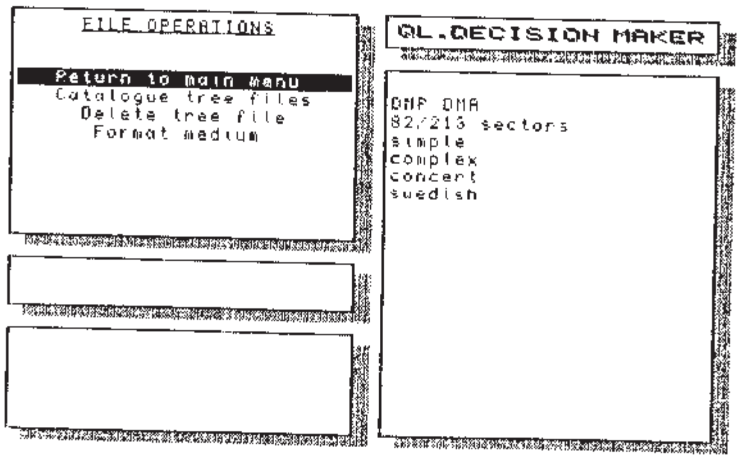
The **Qualitative Probabilities** option is explained in section 12.9.

During the construction of a tree you may have omitted to complete nodes or branches – either deliberately or by accident. The EMV cannot be calculated until the tree is complete with all branches terminated. The **Finish Tree** option will only be displayed if the tree is incomplete. Selecting it will return you to the **DETAIL** mode, where the first of the unfinished nodes/branches will be shown, ready to be completed. Continue using this feature until the tree is complete.

12.6 File Operations

A 'File Operation' occurs when you either save (record) or load (retrieve) information to or from a 'file device'. A 'file device' is any form of mass data storage and the four main types available for your QL are Microdrive cartridges, floppy disks, hard disks and silicon disks. If you are using a disk-based system, you should refer to the disk operating system manual to find out the appropriate device name. The program will require two pieces of information during file operations. The first is the name of the file device which is set for microdrive 2 (mdv2) by default. If you wish to access a different device, delete the default name, type in the new one and press ENTER. Then type in the file name, up to 14 characters long, and press ENTER

If you select **Other File Operations** from the Introductory Menu another screen will appear as follows:



The **Catalogue Tree Files** option will list all the tree files on the device you have selected. A complete catalogue or directory of all files on the nominated device will be shown in the **GLOBAL** window on the right of the screen. These will appear beneath the cartridge or disk name and the free/total sector space available.

Delete Tree File will allow you to delete files from the current catalogue and thus manage your storage and filing from within the program. If you select this you will be asked to type in the name of the file to be deleted. To abort this operation, delete the file name and press ENTER.

The **Format Medium** option will allow you to format blank Microdrives or disks from within the program – remember; the storage medium you are using must be formatted before it will accept data. This facility is particularly useful if you run out of storage space when you are using the program. It is possible, though not usually desirable, to format storage media which contain data, so you will always be asked 'Are you sure (Y/N)?' before formatting begins to prevent accidental erasure. Respond accordingly with Y or N to execute the option.

The two most common file operations of loading and saving files are managed from options on the Introductory and Main Menus. **Load Tree from File Device** is an option on the Introductory Menu. You will be returned to it having cleared the computer's memory prior to loading or starting a new tree. If you select this option, you will be asked for the name of the file. Type it in and press ENTER. If you are unsure of the name of the trees you have on file, use the **Catalogue Tree Files** option to view them. The **Save Tree on file device** option is selected from the Main Menu; refer to section 12.5 for details. Data cartridges or disks should not be 'write protected' during use as this can cause problems with file operations. Two sample data files called **swedish** and **concert** are stored on the Applications cartridge and may be used for trial file operations. These may be 'loaded' from the write protected Applications cartridge but must not be catalogued or deleted.

12.7 Printing out information

The printing routines in this program are installed for Epson FX and RX compatible printers. The contents of either the **GLOBAL** window, or the **DETAIL** window, can be printed out at any point in the program. To indicate the window to be printed, you must 'point' with the flashing cursor. To do this, select either the **GLOBAL** or **DETAIL** option from the **FUNCTION** window. Notice that flashing cursor moves and 'activates' the windows alternately. The active window is the one which will be printed.

Press SHIFT and TAB together to start the printing routine. You will be asked to confirm the baud rate to be used (the speed at which information will be sent to the printer, measured in bits per second). This will initially be set to 9,600, but can be altered using the usual QL editing functions. The new rate will be used for all subsequent printing. Check your printer manual to establish the correct baud rate to be set. Press ENTER to start printing. If you decide to abandon the print out delete the baud rate entirely and press ENTER. A printout of the Risk Profile can be obtained by selecting the 'hardcopy' option when the Risk Profile is displayed in the **DETAIL** window.

Remember: the printer should be attached to serial port 1 (SER1).

12.8 Minimum Payoff

Usually, every branch on the tree is taken into account when the final EMV is calculated. However, certain branches of the tree may contain costs greater than you wish to contemplate. By specifying a figure for the 'Minimum Payoff', you can control your exposure to risk. This is normally used when you wish to avoid all possible exposure to very high costs, even though the chance of them occurring may be very small. Activating this option causes the program to ignore all branches leading to outcomes which are lower than your specified minimum amount. This effectively redraws the tree and recalculates the EMV ignoring the unsuitable branches.

We suggest that you draw and calculate your tree in full first of all to produce an undistorted structure of the decision. By default, no minimum payoff is set but you may enter your own by selecting **Alter Minimum Payoff**. You will be asked to enter your minimum payoff figure which will then remain active until changed; remember; if this is a cost it should be a negative amount. To deactivate this facility, select **Alter Minimum Payoff** from the menu, use **CTRL** and ← or → to delete the figure you have set and press **ENTER**; no minimum payoff figure will then be set.

12.9 Qualitative Probability

The **Qualitative Probability** option is a little more difficult to understand, so be prepared to read what follows more than once. Allocating values to probabilities is never easy and will always require a lot of thought. In certain instances where you find it difficult to specify these accurately you may find it easier to apply qualitative assessments instead of actual figures. The program allows you to use five symbols representing qualitative values instead of actual numeric probabilities. These symbols are the letters U, L, M, H, and E, standing for Unlikely, Low, Medium, High, or Exceptional probability.

The following values are allocated to the qualitative symbols by default:

U = 0.1
L = 0.3
M = 0.5
H = 0.7
E = 0.9

To change the values of these symbols, choose the **Qualitative Probability** option and then select the value you wish to alter using the SPACEbar (as you would to select a menu option). The cursor will then be placed on the selected value, which can be edited using normal QL editing facilities. After you have finished editing a value, set it by pressing ENTER

Use the symbols as you would a probability value; for more details see Section 12.3. Note however, that you cannot mix symbols and values on branches from one node. If you select qualitative values which do not add up to 1, the program will make a pro-rata adjustment to each probability so that they do. As with the allocation of all probabilities, the more accurate your assessment is, the more accurate the answer will be. The allocation and use of probabilities is explained in greater detail in Chapter 5 of the Text Book.

12.10 Function Definitions

To enable you to use Decision Maker more easily many common operations are defined on the QL's function keys. This list of functions will change depending on the current status of the program. The functions currently available are defined in the **FUNCTION** window at the bottom left of the screen. The complete index of available functions is shown below:

OPTION	KEY	FUNCTION
Global Mode	F1	Activates the **GLOBAL** window by displaying a flashing cursor. The contents of the **DETAIL** window are erased when the **GLOBAL** cursor is moved.
Detail Mode	F1	Activates the cursor in the **DETAIL** window ready for data entry and editing.
Main Menu	F2	Returns you to the Main Menu and recalculates the tree, if possible. If a subtree is being displayed in the **GLOBAL** window and you select this option, use **Display Initial Decision** to re-draw the whole tree.

Open Up Node	F3	If you wish to extend a branch that has been terminated, you must first activate the **GLOBAL** window, select the terminal node to be edited with the arrow keys and then press this function to display the blank node in the **DETAIL** window. You will be asked to give the details as usual.
Add Branch	F3	Adds a new branch (up to a maximum of 5) to a node. The new branch is placed above the others with the cursor flashing ready for data entry. All branches from the selected node are erased in the **GLOBAL** window, until you have finished editing, when they are redrawn.
Terminate Node	F4	This option is available only when the **DETAIL** window is active and will change an incomplete Decision or Chance node into a Terminal node.
Draw Subtree	F3	The section of tree following any node except the Initial node is referred to as a subtree. This option causes the **GLOBAL** display to be redrawn to reveal the subtree following the node at the **GLOBAL** cursor position (these may not be displayed because of space limitations). Use it to display a global view of a 'hidden' sub-tree. To return to the Initial **GLOBAL** display, return to the main menu and select **Display Initial Node** option.

Replicating Tree Sections

You may find that you wish to replicate identical sections of tree in more than one position, or that you want to move a section of tree from one node to another within the tree. This is particularly useful if different routes through the tree lead to identical or similar branch structures. The basic manoeuvre is simple; first 'store' a section of tree, then move the stored section and 'chain' it onto a node elsewhere. The original section of the tree will remain in place, but may be deleted if required.

First indicate the initial node of the section to be stored by placing the **GLOBAL** cursor over it. Press **F4, Store Subtree** and all branches and nodes leading from this will be saved in memory. Next move the **GLOBAL** cursor to the node to which you wish to attach the stored subtree and press F5, **Chain Stored Subtree**. The same section will now be linked to the tree at the cursor position. If you wish to add the same section at more than one place, simply repeat the **Chain** option. The store must be cleared before a new section can be stored and chained, use the **Clear Storage** option to execute this.

OPTION	KEY	FUNCTION
Store Subtree	F4	This will store all nodes and branches to the right of the node highlighted by the **GLOBAL** cursor.
Chain Stored Subtree	F5	This will 'chain' or join the stored section of tree to the right of the node indicated by the **GLOBAL** cursor.
Clear Storage	F4	This will clear the stored subtree. The store must be cleared before new sections can be stored and chained.
Delete Branch	F4	This will delete the branch that the cursor in the **DETAIL** window is on and everything following it. Note that a deleted sector is lost irretrievably, so BE VERY CAREFUL when using this option. You will always be asked to confirm if a subtree may be lost.
EVSI	F5	This stands for Expected Value of Sample Information. This option will analyse the EVSI at any chance node

when the EMV of the tree has been calculated. You will be asked to give figures for the value of the zero option, and for the reliability of the sample. (see Chapter 10 for details of EVSI).

12.11 Further Manipulation

Now that you have read through an explanation of all the facilities provided by this program, here are a few ideas on maximising its effectiveness.

One important component of the decision analysis process is sensitivity analysis, that is, testing how sensitive the decisions are to incremental adjustments to various assumptions – particularly the costs, values and probabilities. The computer allows you to input your best guesses first, and then go back into the tree to change each of the variables in turn to see which makes the greatest impact on the outcome.

There are basically only two constraints in the program, you cannot have more than 149 nodes, and each decision or chance node cannot have more than five branches. If you actually come up against either of these constraints, then you should first ask yourself whether you are making things too complicated. If you are convinced that your approach is correct, then here is what you must do:

– More than 149 Nodes:

  Break the tree down into two or more sub trees each of less than 149 nodes and solve them separately.

– More than 5 Branches:

  Introduce a 'dummy' node. Put 4 of the branches on the original node and run a fifth branch to the dummy node. Put the remaining branches onto the dummy. Each dummy will provide up to 5 additional branches – just use as many as you like, but take care with the probabilities on chance nodes, because they must add up to 1 at each node and preserve the desired overall probabilities.

Finally, some clues on major re-editing. The key feature here is the memory facility. Often a tree will have the same sub tree at a number of different points. So, first define it once, and then save it in memory. It can then be linked on wherever it is required. Don't forget, however, that you may need to use the edit routines to change the specific values on the sub tree in different positions. Once a particular sub tree has been stored, it can be chained as many times as you wish without resaving.

The other important use of memory occurs when you want to insert some extra steps into the middle of the tree, or delete some intermediate steps. Simply store the end of the tree in memory, and then edit the main tree as required and link the end back into place.

You may wish to change the nature of a node which is already a part of a tree. This is a complicated task, but can be accomplished as follows:

First, all branches coming from the node to be altered must be transfered, one at a time, to 'spare' terminal nodes using the **STORE**, **CHAIN**, and **CLEAR** facilities. The branches themselves must then be deleted.

Next, the node must be closed, and then opened as a node of the desired type.

After creating the desired number of branches from the altered node, and ending them all with terminal nodes, the original branches may be transfered back to these terminal nodes. Remember also to delete these branches from the original 'spare' terminals.

Postscript

Decision Criteria

The analysis of risk, shown in Chapter 8, gives rise to consideration of whether the approach of using EMV is appropriate in every case. Expected Value is the most popular criterion and it is the one incorporated into the Applications Program, but it does carry the problem that a large negative outcome with a very low probability may be hiding in the result. That is why Chapter 8 emphasises that you must perform a risk analysis on the solution you reach.

One alternative, and very much more conservative criterion which can be applied is known as MAXIMIN. In this approach, the aim is to choose the decision in which the worst possible outcome is the lowest. In our Used Car example, we would choose the guaranteed car, because the worst outcome is a cost of £1000, compared with the possible cost of £1200 for the cheap car. In the Microfruit Dealer case, we would choose not to proceed at all because both of the other alternatives harbour a risk of losing some money. You can use maximin as a criterion if you wish, but in many cases, it will eliminate potentially profitable moves because of a small risk of loss.

Appendix 1

Sample Decision Problems

A1.1 The Used Car Purchase

You are going to buy a five-year-old Ford Escort, either from the local garage for £1000, or from a private seller for £600. The first is fully guaranteed, whilst the second is not. There is a 70% chance that the cheaper car will break down and, if it does, you can sell it or repair it. Repairs may cost £1000 (30% chance) or £300 (60% chance). If you sell it, you will get £800 (60% chance) or £400 (40% chance), but if you do sell, you will have to go straight to the garage to buy the other (£1000) car, because you need the transport.

A1.2 The Microfruit Dealer

You are setting up a new computer showroom. One of the computer manufacturers, Microfruit PLC, has offered you the opportunity to obtain an agency for their range of two computers, the Avocado and the Banana. (We'll call them A and B). You can choose to accept one type A or one type B computer only. If you sell it within a certain time limit, they will offer you one of the other type to sell, but if you fail they will take the computer back and refuse to deal with you any more. On the other hand, if you sell the second one as well, they will appoint you as a dealer. You have calculated the costs involved as follows:

Cost of advertising the Avocado	£ 400
Cost of advertising the Banana	£ 500
Profit from selling the Avocado	£ 200
Profit from selling the Banana	£1000
Net profit from dealership	£5000

We think that the Avocado will be a popular model, and that there is a 60% chance of selling it by the deadline. The Banana, on the other hand, is a much more expensive unit, and so there is only a 20% chance of selling it in time.

A1.3 The Microfruit Shares

You have the opportunity to buy 100 Microfruit shares. You know that they are introducing a new portable computer, the Currant, but that it may be running behind schedule. The Microfruit watchers say that there is a 70% chance that the new computer will be late. If it is late, the shares will fall from £2.30 to £1.50, but if it is on time, they will rise to £6.00.

A1.4 The Swedish Deal

Jim Douglas has the opportunity to close a small deal in Sweden, which will require him to fly over to Stockholm in person. He is expecting a call in the next two weeks which will give him three days notice of the date of the meeting. He has to fabricate a squinge valve to take with him, and this will cost £200 and take 1 day to make. If he wins the deal, he will be able to sell the valve for £800, otherwise it will be valueless.

He can fly there in a regular flight for a return fare of £400 which his travel agent can guarantee to book on any day. Alternatively, he can try to get on the daily standby flight which will only cost £120 return, but there is only a 60% chance of a seat. If he gets to Stockholm with a full day to spare, he will be able to prepare an elaborate presentation, and will stand an 80% chance of winning the deal. If, on the other hand, he arrives just in time, the chances falls to 60%. Finally, if he is late, the deal is off. Our solution to this exercise is contained in a file called 'swedish' on the Applications cartridge.

A1.5 The Charity Concert

The Club has decided to hold a charity concert. If they provide a £50 non refundable deposit immediately, they can book a hall which seats 600, otherwise they will have to hold an outdoor concert in the Park. The latter option has the advantage of being able to accommodate an unlimited number, and it is slightly cheaper, although it means taking a 10% risk of disruption by rain.

Once the early sales of tickets have been measured, a final decision must be taken. The indoor concert can only proceed if the hall has already been booked. Even if it has been booked, it can be cancelled, although the deposit will be lost, and an outdoor concert planned instead. The full cost of the hall is £350, whilst the outdoor venue will cost £200 to set up. If the concert is cancelled, all tickets, selling for £3, will be refunded, but an insurance policy against rain is available, it costs £200, and will pay £1000 if it does rain.

Ticket sales expectations are as follows: if early sales are strong, then there is a 40% chance of selling 700 tickets, 40% chance of 500 and 20% chance of 300 tickets; weak early sales will indicate a 10% chance of selling 700 tickets, 50% chance of 500 and 40% chance of 300. The chance of strong or weak early sales is split 50–50. Should the Club book the hall?

Our solution to this exercise is contained in a file called 'concert' on the Applications cartridge.

Appendix 2

Starting the Program

Load the Teaching, or Applications program according to the following instructions:

Teaching Program

1 Remove any Microdrive cartridges from the QL.
2 Turn the machine on (or reset it).
3 If you want to use the Teaching programs, insert Teaching 1 in Microdrive 1 (left hand side), and Teaching 2 in Microdrive 2 (right hand side).
4 If you want to use the Applications program please refer to the following section.
5 Press **F1** to select the monitor or **F2** for TV.

The programs will now load and run automatically. The loading process may take some time to complete. To make a backup copy of each Teaching Program, place the original cartridge in Microdrive 2 (right hand side) and insert a blank cartridge in Microdrive 1 (left hand side). Type **lrun mdv2_backup**, a screen message will appear, press **ENTER** and a backup copy will be made on Microdrive 1.

Applications Program

This program is protected by a 'key' mechanism which prevents illegal copying. The way this works is that though the program can be copied freely, it can only be run if the original 'key' cartridge is in drive 2. To run the program for the first time, you will have to make a copy on a blank cartridge as follows:

To copy the program – this must be done on first time use:

1 Reset your QL.
2 Press F1 (for monitor) or F2 (for TV).
3 Put the original Applications Program cartridge in Microdrive 2 (right hand side).
4 Insert a blank cartridge in Microdrive 1 (left hand side).
5 Type in lrun mdv2_config and press ENTER. Microdrive 2 will now operate.
6 A series of 4 instructions will appear on the screen. Simply press ENTER after each.
7 The Cartridge in Microdrive 1 will now be formatted and the Applications Program copied automatically. This may take some while, during which there may be significant pauses – DO NOT TOUCH YOUR QL until the message "Copying Complete" appears *and* the Microdrives stop running.
8 If a failure occurs in this routine, an error message will be displayed. Repeat this sequence from 1, ensuring you read the instructions carefully. If the error messages "Format Failed" or "Bad Medium" appear, you should replace the cartridge or disk you are using.
9 If you now wish to run the program, remove the cartridges and reset the machine. Replace the working copy in Microdrive 1 (left hand side) and the original program in Microdrive 2 (right hand side).
10 Press F1 or F2 as appropriate and wait until the program has loaded and the initial screen is displayed. The original cartridge in Microdrive 2 may now be withdrawn.

In normal use:

11 Reset your QL.
12 Follow the instructions from 9.
13 You may make as many security copies as you like, but you must *always* load the program with the original or 'key' installed.

For other devices:

14 You may configure the program and data devices for any medium.
15 Follow the sequence from 1 to 3. Any combination of devices may be used for program transfer. The messages use the following terms:

Source device: The device from which you are copying – usually mdv1 or mdv2, but may be a disk.

Program device: The device on which you wish to save the working copy of the program.

Data device: This is the default device used for data storage during program operation.

16 All device names must be 4 characters long. If you are unsure of the device name, consult the device manual.

Running the program from another device:

17 If you are using a disk system which incorporates autobooting from disk, insert the working copy in the disk drive and the 'key' (original) in Microdrive 2. Reset your QL and press F1 or F2 to load the program.

18 If the device does not have an autoboot facility, reset your QL and insert the 'key' (original) cartridge in Microdrive 2. Put the working copy in the disk drive and type lrun ****_boot and press ENTER (where **** is the device name).

Please note, you will not be able to copy any more than one Applications Program per disk. If you wish to use the program on disks then we recommend you allocate one whole disk to your program and data files.

Glossary

Action, an event which the decision maker can choose to cause to occur.

Bayes Theorem, is a method used to calculate the revised probability of an event when additional information becomes available.

Chance Node, a point on a **Decision Tree** where the decision maker cannot choose what is to happen next.

Decision Node, a point on a **Decision Tree** where the decision maker has full control over what is to happen next.

Decision Analysis, a method of selecting the best course of action through a complex sequential decision problem.

Decision Tree, the diagrammatic representation of a sequential decision problem.

Expected Monetary Value (EMV), the average value that a situation or event would have if it was repeated many times.

Expected Value of Perfect Information (EVPI), the increase in the **EMV** brought about by being able to predict with certainty the outcome of a series of otherwise chance events.

Expected Value of Sample Information (EVSI), the increase in **EMV** brought about by obtaining additional information about the probable outcome of a series of chance events.

Interactive, in computer terminology, the process whereby the function of the computer is dependent upon the responses of the user.

Maximin, a decision criterion by which the decision is made which has a worst outcome less severe than the worst outcome of any alternative course of action.

Outcome, the result of a Chance Event.

Payoff, the EMV of a terminal node on a **Decision Tree**, calculated by summing the costs and values of the sequence of events which leads to that node.

Probability, the measure of the chance that a particular event will occur. It is given by a number in the range of 0 (for impossible) to 1 (certain).

Risk Profile, a schedule of all the payoffs which can occur if only the highest value decisions are taken, together with their probabilities.

Roll-Back, the process of calculating the **EMVs** of all the nodes of a **Decision Tree,** in sequence, from the last to the first.

Sensitivity, a measure of how much the basic costs, values and **probabilities** need to change to alter the preferred decision.

Bibliography

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2 Coping with Numbers, by David Targett, Martin Robertson 1983

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