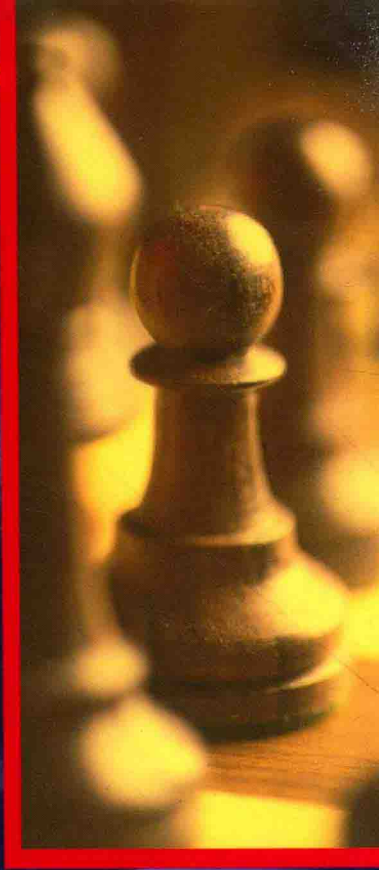
DECISION ANALYSIS, GAME THEORY, AND INFORMATION



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Decision Analysis, Game Theory, and Information

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Preface

Lawyers frequently make strategic decisions regarding their clients' interests, ranging from whether to settle a lawsuit to what sort of contract design to propose. *Decision Analysis, Game Theory, and Information* teaches the basics of decision analysis and game theory, which are the fundamental tools used over the past half-century by clients, whether businesses, government institutions, other entities, or individuals. Special attention is given to the use of these techniques in litigation. An overview of moral hazard, adverse selection, and other problems of imperfect information, as well as an introduction to bargaining (negotiation), is also included. This Handbook can be used as a supplementary text for a first-year civil procedure course, and would also be appropriate for courses on negotiation, legal methods, or law and economics.

This Handbook is drawn from Foundation Press's textbook, *Analytical Methods for Lawyers*, which was created to accompany a course we and other professors have taught for the past five years at Harvard Law School. The course and the original text grew out of our joint realization that the traditional law school curriculum, with its focus on the development of analogical reasoning skills and legal writing and research, left many law students inadequately prepared for upper-level law courses and, more importantly, for legal practice in the modern world. Lawyers, whether corporate counsel or public interest advocates, must work in settings where effective argumentation and the giving of sound legal advice often depend on mastery of language and techniques derived from a range of disciplines that are staples of the modern business school curriculum but notably absent, in introductory form, from law school classrooms.

True, a number of students arrive at law school well equipped with general knowledge of some of these areas from their undergraduate or work experiences. Equally true, however, is that many, perhaps the majority, of law students are woefully underprepared in these areas. They may self-select away from upper-level courses in which their inadequate preparation would severely disadvantage them. These students will graduate from law school without a set of basic skills, the absence of which will hamper their development in almost any of the careers that law graduates now pursue. Moreover, even those students who do have strong general preparation are often unacquainted with how what they have learned may be used effectively by practicing lawyers. It has been our experience that many students are themselves acutely aware of their deficiencies (or are made aware of it when they encounter certain discussions in first-year classrooms or when they receive their first assignments in a summer job or internship). Such students are eager to have their legal education enhanced by material like that in this Handbook, which promises to demystify analytical concepts and quantitative techniques that they see as clearly relevant to success in their law school coursework and, ultimately, to success in their chosen careers. It is primarily for these students that this Handbook has been written.

Unlike traditional introductory treatments, this Handbook is not a dry or technical text, far removed from the world of law. Quite the opposite. Virtually every concept is introduced, explained, and applied in legal contexts. Additionally, this Handbook is designed to be used to facilitate problem-based classroom discussion, materials for which are available to instructors in a Teachers' Manual. The translation from theory to practice is not left for students to develop on their own, after graduation. Instead, it is at the very heart of this Handbook.

Cambridge, Massachusetts
July 2004

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Decision Analysis

1. Introduction

Lawyers have to make all kinds of decisions — some of them quite complex — when conducting litigation or counseling clients. Obviously, lawyers and clients would like all their decisions to be the best ones possible. The surest way to reach this goal is by proceeding through the decision-making process in an organized and methodical way. Decision analysis provides a tool for doing just this. It's an organized method of making decisions — indeed, an enthusiast might even say that it is *the* rational way to go about making decisions — that is especially valuable when decisions have to be made in the face of uncertainty and when one decision must be followed by subsequent decisions.

Here are several typical decision-making problems of the types that you might encounter in your practice of law:

- *Automobile accident settlement negotiation.* You're the lawyer for a plaintiff who was in an automobile accident, and you're involved in settlement negotiation with the defendant's lawyer. If you go to trial, there will be three possible outcomes. First, you might win and prevail on the major issue of damages: lost wages. In this event, your client will receive a total award of $100,000. The likelihood of this outcome, in your opinion, is 50%. Second, your client may win at trial but not obtain lost wages. In this case, she'll receive only $20,000 for

the damage to her car. You think that the chances of this outcome are 30%. Third, your client might lose at trial and thus win nothing. In your estimation, the probability that this will be the outcome is 20%. Going to trial would cost $10,000. The defendant has offered $40,000 to settle the case. Should you advise your client to accept this offer?

- *Land purchase decision.* Your client, who wishes to build a restaurant, is trying to decide which of two parcels of land to buy. Parcel A has been offered at $300,000 and Parcel B at only $250,000. They seem equally attractive, so your client initially thinks that purchasing the cheaper one, Parcel B, is the way to go. However, in questioning the sellers about the parcels, you learn that Parcel B may have an environmental problem because wastes have been dumped on it, whereas no problems are associated with Parcel A. You find that if the wastes on Parcel B are hazardous, the law would require your client to clean up the site and that the cost of cleanup would be $200,000. You figure that the odds of Parcel B having this problem are 50%. But before your client decides which parcel to buy, you can hire an environmental testing firm to determine definitively whether your client would have to clean up Parcel B. Having the environmental firm do the testing would cost your client $20,000. Should you advise your client to have the testing done? Or should he just buy Parcel A? Or Parcel B?
- *Tax deduction advice.* You're a tax lawyer advising a client about a tax matter and don't know whether a particular tax deduction — one that would save her $80,000 — is allowable (it's a judg-

ment call that involves no ethical issue). If she takes the deduction, she'll be audited with probability 75% (she's in a group that's often audited for such deductions). If she's audited, the odds that the deduction will be found to be allowable are 50%. If she's audited and the deduction is disallowed, she won't obtain the $80,000 benefit, and she'll have to pay a penalty of $20,000. Should you advise her to claim the deduction?

- *Medical decision and negligence issue.* You are a lawyer helping a health maintenance organization formulate a medical treatment policy that will prevent it from being sued for negligence. For patients with a certain kind of heart ailment that will lead to immediate death if untreated, there are two options, both involving substantial risk. The first is a course of drug treatment, which will be successful 50% of the time but will also fail to prevent death 50% of the time. The second option is corrective surgery. The operation will be successful 33⅓% of the time. It won't go well and will result in patient death 10% of the time. The rest of the time it won't solve the problem and will leave the patient in a weakened condition. In this case, the patient's only option will be treatment with the drug, but now the drug has only a 25% chance of working. Neither the drug treatment nor the corrective surgery is very expensive in relation to any reasonable valuation of life, so it would be negligent not to choose some method of treatment. The question is, to avoid a finding of negligence, which method should be chosen (assuming that cost is not taken into consideration in the negligence determination)?

We'll use decision analysis to work through some of these problems, as well as some others, a little later in this Handbook. But, as an experiment, you might try to solve them right now on your own, if only to see how difficult the process sometimes can be.

Decision analysis is useful for a number of reasons. Some decisions are quite complicated to make — because of the number of choices, the number of possible consequences and their likelihoods, and the significance of decisions at each stage for later decisions. Therefore, more than intuition is often needed to see through to an answer, and decision analysis can fill this void.

Decision analysis is also useful because it forces us to be explicit about the considerations relevant to making a decision. It requires that we write down all the factors that might influence us. This process itself frequently yields significant dividends. In addition, listing all the potential consequences of a decision, assessing the likelihood of each, and noting all subsequent decisions that might have to be made down the road commonly reveals relevant issues and possibilities that would otherwise have been overlooked. In this regard, the sketches above may be a bit misleading, because the relevant events, their likelihoods, and future actions were laid out. In real life, we have to figure out for ourselves what they are.

As is obvious from the sketches, decision analysis can be relevant and helpful both to lawyers who are involved in active litigation and to lawyers who are advising clients before disputes arise. Much of the work that's necessary in making decisions to help clients is work that has to be done by lawyers: it is the lawyers who are often in the best position to identify many relevant contingencies, their likelihoods, and their significance. For instance, in the settlement negotiation sketch, the lawyer will have the best knowledge of the odds of winning this or that amount in the judgment. In the land purchase example, the lawyer might be the person who will be on the lookout for possible environmental problems (the environmental issue might not be on the radar screen of someone who doesn't purchase land very often), who

will know what types of wastes have to be removed and precisely what the cleanup obligation entails, who will be familiar with waste-testing firms, and so forth. For such reasons, many lawyers themselves explicitly use decision analysis. Some hire consultants to teach them how to work through the decision analysis process. Others hire consultants to do the decision analyses.

Moreover, decision analysis is a mainstay of business and government decision making and is increasingly used in the medical world and in other arenas. A knowledge of decision analysis will prove useful to you in your practice not only because it will be of direct value to when you're making decisions but also because it will allow you to better understand the situation at hand and to communicate more effectively with your clients.

Box 1
Is Decision Analysis Ethical?

Is using decision analysis always ethical when doing so would be helpful to your client? For example, is employing decision analysis always ethical when giving tax advice? The answer, of course, is that your general ethical and legal obligations as a lawyer should guide you in providing advice to your client. There's nothing special per se about legal advice that makes use of decision analysis. Thus, if your client is seeking tax advice in the face of uncertainty about the interpretation of tax laws (as in our tax deduction example), decision analysis is good to employ. But if your client is trying to evade taxes clearly owed, it's wrong to knowingly aid your client, be it with decision analysis or in any other way.

2. Decision Trees

The first step in decision analysis is to convert a problem into a standard format: a *decision tree.* This format, which is quite intuitive, has proven to be very helpful. It displays all the decisions that are possible and all the consequences that are possible, along with their probabilities and their importance, the latter often being expressed in monetary terms. (How this information is obtained is another matter, which we'll explore a little later. For now, we'll assume that the decision maker has it.) Once a decision tree is displayed, it has to be solved. The process of solving a decision tree, like the format itself, is intuitive.

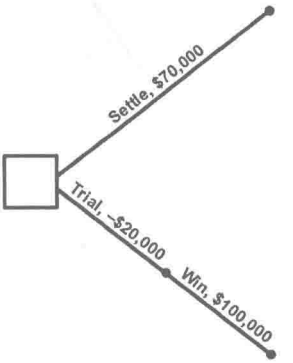
A. A Simple Problem

Let's begin by focusing on an extremely simple settlement decision. Suppose that your client is the plaintiff in a contract case. If he proceeds to trial, he will surely win, because the case is a slam-dunk: there was a clear breach of contract. The amount your client will receive if he goes to trial is $100,000, and legal costs will be $20,000, so your client will net $80,000. The defendant has offered your client $70,000.

The tree diagram for this scenario is shown in Figure 1. As we can see, it begins on the left with a box, a *decision node.* Two lines, referred to as *decision branches,* emanate from the box. They represent each of the two possible decisions that you can make: Settle (i.e., accept the settlement offer) and Trial (i.e., reject the offer and go to trial).[1] The $70,000 written along the Settle branch is the amount your client will receive if he settles. This is the *payoff,* or *consequence,* corresponding to the decision branch Settle. A negative amount, –$20,000, is noted along the Trial decision branch. This is the cost of going to trial. The payoff notation is followed by $100,000, the amount won at trial. Determining which

1. In a decision tree, the number of lines extending from a decision node always equals the number of decisions that are possible.

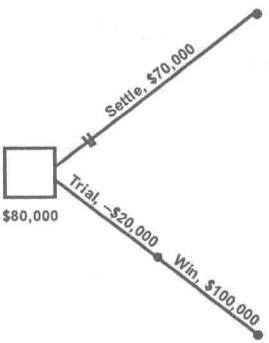
Figure 1
Settlement versus Trial



branch to choose, Settle or Trial, is readily apparent in this tree: if you settle, you get $70,000, and if you go to trial, you net $80,000. You would, obviously, choose Trial.

To indicate that a decision branch has been eliminated, we strike two lines through that line branch (see Figure 2). Similarly, the payoff when the best decision is made at a decision node is written underneath the decision node (e.g., the $80,000 in Figure 2).

Figure 2
Settlement versus Trial: The Best Decision



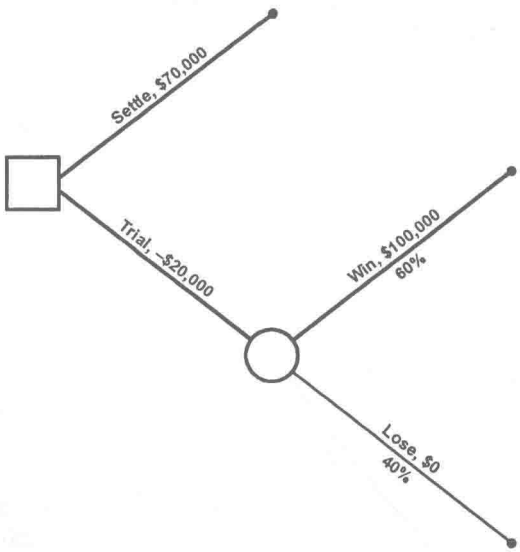
Striking off eliminated decision branches and recording under the decision node the best possible payoff is conventional practice in decision analysis. This practice may seem unnecessary to you at this point, but it proves to be very helpful when dealing with more complicated decision problems, as will soon become clear.

B. Uncertainty

Now let's introduce the element of uncertainty into our story. Suppose that your case for breach of contract is not a sure thing, because the other side has a possible counterargument. You think that the odds of prevailing at trial are only about 60%. If the decision doesn't come down on your side, your client will lose and collect nothing. This scenario is illustrated in Figure 3.

Notice that a circle is drawn at the end of the decision branch Trial. This circle, a *chance node,* signifies that chance will play a role in what next happens. In our example, your client either will

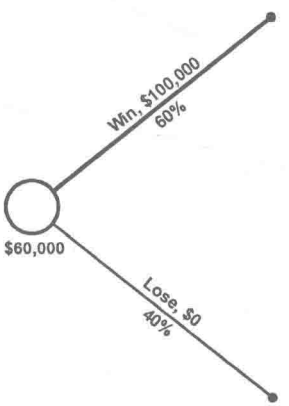
Figure 3
Settlement versus Trial: Uncertainty



Win and gain $100,000 or will Lose and receive $0. Each outcome is indicated along a *chance branch,* and its likelihood is written under the branch. Thus, the tree diagram in Figure 3 contains all the relevant information provided by the verbal description of the problem.

Now that we have a visual representation of the problem, how do we evaluate the uncertain payoffs from trial? Let's focus on just a part of the decision tree, the uncertain chance branches for Trial (see Figure 4). How does it make sense to evaluate this situation, where there's a 60% chance of gaining $100,000 and a 40% chance of obtaining nothing? Plainly, if the chances of winning $100,000 were 100%, the evaluation of the situation would be $100,000. Just as clear is that, if the chances of winning anything were 0%, the evaluation of the situation would be $0. What we're confronted with, however, is a situation where you will Win with a probability of 60% and Lose with a probability of 40%. Intuition suggests that the evaluation of the situation should be somewhere between $100,000 and $0.

Figure 4
Chance Branches



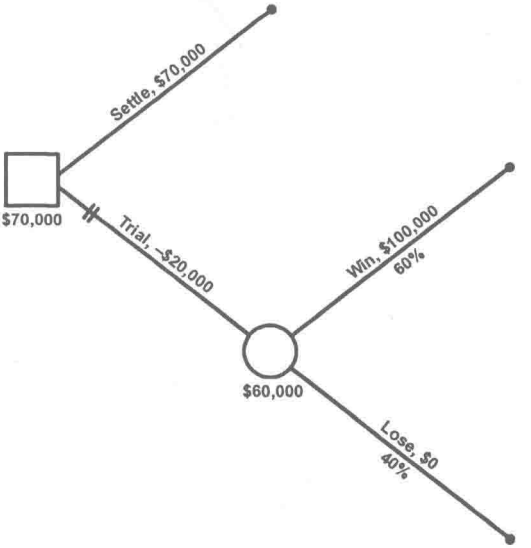
How do we decide what amount between $100,000 and $0 to use? The natural choice would seem to be the *expected value,* which is the probability of the payoff multiplied by the amount of the payoff. In this case, the expected value is $60,000 (i.e., 60% × $100,000 = $60,000). The expected value is the obvious, natural number to use as an evaluation because it is the average payoff a person would obtain if repeatedly faced with a risky situation similar to the type in question. Suppose that you find yourself repeatedly in trial situations in which you feel the odds of winning $100,000 are 60% (and the odds of winning $0 are 40%). You don't know what will happen in any one trial, of course, but you would know what your average winnings would be over the course of many of these trials: about $60,000. In other words, if you were to repeat the situation under discussion 100 times and anticipated obtaining $100,000 in 60 trials and gaining nothing in the other 40 trials,[2] your total gain would be $6,000,000 (i.e., 60 × $100,000 = $6,000,000), and thus your average gain would be $60,000 (i.e., $6,000,000/100 = $60,000).

For the time being, let's accept expected value as an appropriate measure or value of chance events and return to the decision tree in Figure 4. In this example, $60,000 is the expected value of the chance events following from the decision to go to trial, so we write $60,000 under the chance node. This notation indicates that we evaluate the chancy situation as if it were worth $60,000.

If we look again at the full decision tree, in Figure 5, we can see that we're now in a position to compare the two decision branches, Trial and Settle. It's apparent that Trial is worse than Settle. Trial requires an expenditure of $20,000 and leads to the chance node worth $60,000, yielding a net of $40,000, whereas Settle is worth

2. This distribution of trial outcomes, 60 and 40, is suggested by the probabilities 60% and 40%. The actual number of outcomes of each type might well be different, but usually the number of wins in 100 trials would be close to 60 if the likelihood of winning each is 60%.

Figure 5
Settlement versus Trial: Uncertainty and the Best Decision



$70,000. Hence, Settle is the better decision. We therefore strike off the decision branch Trial, leaving Settle as the better of the two possible decisions that you can make with your client. We also note the payoff — $70,000 — under the first decision box to indicate that this is the amount that will be obtained if you make the best decision, Settle.

C. Risk Aversion

You might be thinking that your client wouldn't necessarily have assigned a $60,000 value to the chancy situation in which $100,000 is won with a 60% probability and $0 gained with a 40% probability. Perhaps your client is scared of the possibility of ending with nothing (in addition to having to spend $20,000 on litigation) and really needs to wind up with some positive amount of money. In such a case, your client would evaluate the chancy situ-