A DECISION TREE MODEL AND ITS ANALYSIS

Decision analysis is a logical and systematic way to address a wide variety of problems involving decision-making in an uncertain environment. We introduce the method of decision analysis and the analytical model of constructing and solving a decision tree with the following prototypical decision problem.

BILL SAMPRAS' SUMMER JOB DECISION

Bill Sampras is in the third week of his first semester at the Sloan School of Management at the Massachusetts Institute of Technology (MIT). In addition to spending time preparing for classes, Bill has begun to think seriously about summer employment for the next summer, and in particular about a decision he must make in the next several weeks.

On Bill's flight to Boston at the end of August, he sat next to and struck up an interesting conversation with Vanessa Parker, the Vice President for the Equity Desk of a major investment banking firm. At the end of the flight, Vanessa told Bill directly that she would like to discuss the possibility of hiring Bill for next summer, and that he should contact her directly in mid-November, when her firm starts their planning for summer hiring. Bill felt that she was sufficiently impressed with his experience (he worked in the Finance Department of a Fortune 500 company for four years on short-term investing of excess cash from revenue operations) as well as with his overall demeanor.

When Bill left the company in August to begin studying for his MBA, his boss, John Mason, had taken him aside and also promised him a summer job for the following summer. The summer salary would be $12,000 for twelve weeks back at the company. However, John also told him that the summer job offer would only be good until the end of October. Therefore, Bill must decide whether or not to accept John's summer job offer before he knows any details about Vanessa's potential job offer, as Vanessa had explained that her firm is unwilling to discuss summer job opportunities in detail until mid-November. If Bill were to turn down John's offer, Bill could either accept Vanessa's potential job offer (if it indeed were to materialize), or he could search for a different summer job by participating in the corporate summer recruiting program that the Sloan School of Management offers in January and February.

Bill's Decision Criterion

Let us suppose, for the sake of simplicity, that Bill feels that all summer job opportunities (working for John, working for Vanessa's firm, or obtaining a summer job through corporate recruiting at school) would offer Bill similar learning, networking, and resumé-building experiences. Therefore, we assume that Bill's only criterion on which to differentiate between summer jobs is the summer salary, and that Bill obviously prefers a higher salary to a lower salary.

Constructing a Decision Tree for Bill Sampras' Summer Job Decision Problem

A decision tree is a systematic way of organizing and representing the various decisions and uncertainties that a decision-maker faces. Here we construct such a decision tree for Bill Sampras' summer job decision.

Notice that there are, in fact, two decisions that Bill needs to make regarding the summer job problem. First, he must decide whether or not to accept John's summer job offer. Second, if he were to reject John's offer, and Vanessa's firm were to offer him a job in mid-November, he must then decide whether to accept Vanessa's offer or to instead participate in the school's corporate summer recruiting program in January and February.

These decisions are represented chronologically and in a systematic fashion in a drawing called a decision tree. Bill's first decision concerns whether to accept or reject John's offer. A decision is represented with a small box that is called a decision node, and each possible choice is represented as a line called a branch that emanates from the decision node. Therefore, Bill's first decision is represented as shown in Figure 1.1. It is customary to write a brief description of the decision choice on the top of each branch emanating from the decision node. Also, for future reference, we have given the node a label (in this case, the letter "A").

If Bill were to accept John's job offer, then there are no other decisions or uncertainties Bill would need to consider. However, if he were to reject John's job offer, then Bill would face the uncertainty of whether or not Vanessa's firm would subsequently offer Bill a summer job. In a decision tree, an uncertain event is represented with a small circle called an event node, and each possible outcome of the event is represented as a line (or branch) that emanates from the event node. Such an event node with its outcome branches is shown in Figure 1.2, and is given the label "B." Again, it is customary to write a brief description of the possible outcomes of the event above each outcome branch.

Unlike a decision node, where the decision-maker gets to select which branch to opt for, at an event node the decision-maker has no such choice. Rather, one can think that at an event node, "nature" or "fate" decides which outcome will take place.

The outcome branches that emanate from an event node must represent a mutually exclusive and collectively exhaustive set of possible events. By mutually exclusive, we mean that no two outcomes could ever transpire at the same time. By collectively ex-haustive, we mean that the set of possible outcomes represents the entire range of possible outcomes. In other words, there is no probability that another non-represented outcome might occur. In our example, at this event node there are two, and only two, distinct outcomes that could occur: one outcome is that Vanessa's firm will offer Bill a summer job, and the other outcome is that Vanessa's firm will not offer Bill a summer job.

If Vanessa's firm were to make Bill a job offer, then Bill would subsequently have to decide to accept or to reject the firm's job offer. In this case, and if Bill were to accept the firm's job offer, then his summer job problem would be resolved. If Bill were to instead reject their offer, then Bill would then have to search for summer employment through the school's corporate summer recruiting program. The decision tree shown in Figure 1.3 represents these further possible eventualities, where the additional decision node C represents the decision that Bill would face if he were to receive a summer job offer from Vanessa's firm.