According to Nobel prize-winning economist Herbert Simon, the essence of management is decision making. Managers must make decisions on how to organize an office, how to evaluate a program, the necessary skills needed in an agency position, how to motivate employees, and numerous other tasks in a public organization. A large body of literature has sprung around the idea of management as decision making. This chapter will overview decision theory and its uses for public managers. Many of the approaches outlined in this chapter can be used to solve problems found in the other chapters.

The Rational Decision-Making Model

An ideal type of decision making has surfaced in a variety of management areas. Planning, program evaluation, performance appraisal, and budgeting are often structured to meet the ideal, rational decision-making goal. Many management theorists argue that good managers attempt to attain this ideal decision-making pattern. Although this position is not without challenge, rational decision making should be part of every manager's skills.

There are five steps in rational decision making.

Step 1: Identify the problem. Although this first step appears simple, in many situations it is not. The U.S. Army, for example, has noted increased disciplinary problems, including drug usage, among its troops. The immediate problem is discipline, but the underlying problem may be something else. Inadequate training, lack of meaningful work assign-
ments, absence of effective supervision, inadequate leadership, or recruitment problems generated by the volunteers' army may be the real problem. Failure to identify the problem correctly may lead to a poor decision. If inadequate training is the problem and it results in less discipline, increasing punishments may have no impact on the discipline of troops. One secret of good management is to be able to diagnose problems correctly.

**STEP 2**
Specify goals and objectives. Given a specific problem, exactly what does the organization wish to do? A state welfare office may have a problem if its payments are too high given the agency's resources. How the agency responds to this problem depends on its goals. If the goal is simply to lower costs, tax word can be passed to deny more claims. If the goal is to restrict the amount of waste, control mechanisms to catch fraud could be implemented. If the goal is to make welfare recipients self-sufficient, then providing recipients with needed job skills might be an alternative. Without carefully specified goals, the rational decision-making model cannot function.

Specifying goals, although it seems a rational and commonplace thing to do, is not without its problems. First, whenever more than one person must accept a goal (normally the case in a public organization), agreement on goals becomes problematic. An individual's perception of agency goals will be a function of that person's role in the organization and that person's individual values and preferences. City planners, for example, may feel that the goal of an urban renewal project is to beautify the city. The chief fiscal officer may see the project as a way to increase the city's tax base. The community development director may see the project as a means of increasing employment opportunities through construction jobs. The public works head may see the project's goal as providing city government office space. These and numerous other goals can logically be offered as the goal of an urban renewal project. Without agreement on the goal of the project, decision making becomes difficult.

Second, as illustrated before, any one project or agency can have numerous goals. Even as simple a task as refuse collection can have several goals. Refuse is collected to avoid health problems that occur when garbage sits in alleys. Refuse collection also has cost goals; city managers would like to collect trash as cheaply as possible. Refuse collection has service goals; city residents may want garbage collected twice a week so that it does not pile up in yards. Multiple objectives mean several goals must be sought simultaneously, and this restriction creates problems for decision makers.

Third, where multiple goals exist, some are bound to conflict. In our example of urban renewal, maximizing employment opportunities may well conflict with the goal of holding down costs. Increasing the city's

tax base conflicts with increasing the available city government office space. If conflicts between goals cannot be resolved, rational decision making is not possible.

**Fourth, goal expression raises the specter of suboptimization. A single goal subsumes all equity maximizing its goals or a single agency of government maximizing its goals may produce results detrimental to the overall organization's goals. An audit division, for example, that is offered an endowment to prevent the waste of taxpayers' money may place such restrictions on operating agencies that the agencies spend more time responding to fiscal control than they spend delivering services. Although this situation may be rational for the audit agency, it is not rational from a government-wide perspective.

**STEP 3**
Specify all alternatives available to attain the goals. Once goals have been established, the decision maker must then specify all the alternatives available to achieve the goals. This does not mean the decision maker must list every alternative no matter how ridiculous; rather, some judgment is exercised to limit the alternatives considered to those that are politically and managerially feasible. The Florida State director of welfare, for example, when faced with the goal of reducing welfare costs, does not consider the alternative of simply firing up all welfare recipients and shooting them.

**STEP 4**
Evaluate the alternatives in light of the goals. Each alternative is examined to see whether it will attain the goals in question. All alternatives capable of attaining the ends in question are then compared to determine which alternative is the most likely to achieve the goals. At this stage of decision making, a variety of analytical tools can be used to contrast alternatives. Cost-benefit analysis, in which program costs are contrasted with program benefits, is the favorite of many program evaluators. Direct and indirect, as well as present and future, costs and benefits must be included. Creative analysis is needed to include the unanticipated second-order costs and benefits (a successful drug rehabilitation program, for example, will reduce the crime rate for robbery and burglary). Other benefits of cost-benefit analysis, including system analysis, risk analysis, and feasibility analysis, are also used.

The evaluation of alternatives need not be a sophisticated mathematical assessment. Alternatives may be judged on the basis of past experience, political information, and so on. In fact, these extraneous methods of analyzing options are often the only methods available to the decision maker. Even when sophisticated methods of analysis exist, the manager must determine how realistic the evaluation models are.
manager cannot defend a failure by blaming a cost-benefit model (at least not more than once)."
Chapter 3

of logic or past experience, assign probabilities to the various states of nature. Decision making under risk is best illustrated with an example.

The city of Reginald, Ohio, must choose between one of three types of employment programs. The effectiveness of each program depends on the state of the unemployment (the state of nature). What are the steps involved?

**OPTION 1**

Do nothing. Reginald can simply ignore the problem and hope that the market will correct itself. If the unemployment is low, the city will not need to spend any funds. If unemployment remains moderate (5-9%), then costs to Reginald in terms of unemployment will be moderate. If unemployment is high (10% or above), unemployment will become a disaster, with reduced demand for goods manufactured in the Reginald area and a major recession.

**OPTION 2**

Operate a job placement center to find new jobs for currently out-of-work people. Option 2 has a minor cost if unemployment is low, but returns major benefits where unemployment is moderate (5-9%). Under moderate unemployment, the program fills sufficient gaps in the labor market; however, if unemployment is high, the placement program will be inadequate.

**OPTION 3**

Implement a job training program. If unemployment is below 5%, this program's high fixed costs make it an unattractive alternative. Under moderate unemployment (5-9%), the program has some costs, the program provides possible jobs to those unemployed; however, it absorbs surplus labor and fills the workforce's skills.

Reginald's choice of employment programs can be analyzed as a decision under risk. To do so, the following steps must be implemented.

<table>
<thead>
<tr>
<th>Table</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STEP 1</strong></td>
</tr>
<tr>
<td>Set up a decision table. Place each of the states of nature (in this case, low, moderate, and high unemployment) across the top of the table. Note that the states of nature cover all conceivable possibilities. Place each of the decision options down the left-hand side of the table. The decision table of Table 21.1 results.</td>
</tr>
<tr>
<td><strong>STEP 2</strong></td>
</tr>
<tr>
<td>Calculate the payoff to the city for each cell in the decision table. That is, what is the cost or benefit to Reginald if unemployment is low and the city does nothing? What is the cost to the city if unemployment is low and the city runs a placement service? Payoffs may be calculated in a variety of ways. The manager may assign payoffs based on past experience; cost-benefit calculations can be done for each option; and so on.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 21.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision Table for Reginald, Ohio</td>
</tr>
<tr>
<td>Decision</td>
</tr>
<tr>
<td>Do nothing</td>
</tr>
<tr>
<td>Placement</td>
</tr>
<tr>
<td>Job training</td>
</tr>
</tbody>
</table>

To interpret this table, one merely assigns the values listed to the decision options given a certain state of nature. For example, if unemployment is high and the city does nothing, the cost to the city will be $120,000.

**STEP 3**

Determine the probability that each state of nature will occur; that is, for the period that the decision will cover, what is the probability of low unemployment (less than 5%), moderate unemployment (5-9%), or high unemployment (greater than 10%)? Mayor Caruthers asks Calvin Kent, a local economic consultant, to forecast the probability of low, moderate, or high unemployment. Kent predicts a 2 probability of low unemployment, a 3 probability of moderate unemployment, and a 5 probability of high unemployment. These figures are placed in the table next to the states of nature (see Table 21.3).

**STEP 4**

Calculate the expected value for each decision option. The expected value of any choice (decision option) is the sum of all the values that can
The expected value for option 2, the placement option, is as follows:

\[ EV = (2 \times -30000) + (3 \times -50000) + (5 \times -50000) = -20000 \]

The expected value for option 3, the job training option, is:

\[ EV = -3 \times 20000 + 3 \times 10000 + 5 \times 140000 = -22000 + 30000 + 70000 = 51000 \]

Mayer Caruthers’s decision should be obvious. The expected value of doing nothing is a loss of $57,500. The expected value of placement is a loss of $20,000, and the expected value of job training is a benefit of $51,000. The mayor selects the job training program.

A CAVIAR

Decision making under risk makes some assumptions that may not be attractive to decision makers. First, it assumes that the decision maker has the same attitude toward risk regardless of the size of benefit involved. The expected value of a decision with a 25% probability of a $10,000 loss is the same as the expected value of a decision with a 0.05 probability of a $1 million loss. A manager might well be willing to take the first risk yet find the second one unacceptable. Decision theory in the form presented above cannot incorporate this willingness to take risks. Second, the model assumes that expected value covers all the values the decision maker wants to maximize. A public sector decision maker may want to incorporate different values. If Milton Friedman were mayor of Reginald, he might wish to err on the side of less government and do nothing—or at most run only a placement program. Other public managers might echo Franklin Roosevelt’s sentiments when he conceded that his policies might be wrong, but that it was better to try and fail than to not try at all. Both the amount of risk tolerated and the additional values considered are political criteria. These criteria, in addition to the results of the decision table, must be considered by public managers and policy analysts.

THE VALUE OF PERFECT INFORMATION

Mayer Caruthers is visited by J. Barrington Tipton of Chase Econometrics, a well-known economic forecasting firm. Tipton tells Caruthers that Chase can
accurately forecast the unemployment rate in Regina for the next year. Caruthers is enlisted until Tippon tells her that the forecast will cost Ragnall $25,000. Should Caruthers hire Chance to forecast her? Another way of asking this question is to ask, What is the value of perfect information? (Perfect information means that you can specify the exact state of nature in advance.) Without any information concerning the states of nature (except their probabilities), Caruthers selected option 3, the job training program, with a value of $51,000. The figure needs to be compared with the expected value if the city had perfect information.

### Table 21.4

<table>
<thead>
<tr>
<th>Decision Options</th>
<th>Unemployment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low (2)</td>
</tr>
<tr>
<td>Do nothing</td>
<td>$20K</td>
</tr>
<tr>
<td>Placement</td>
<td>$10K</td>
</tr>
<tr>
<td>Job training</td>
<td>$110K</td>
</tr>
</tbody>
</table>

Refer to the payoff table, Table 21.4. If the city knew that unemployment would be low, it would do nothing and reap a benefit of $20,000. Since low unemployment will occur 20% of the time, the expected value of this occurrence is $4000 (20% x $20,000). If the city knew that unemployment would be moderate, the best decision would be to a placement program with a payoff of $50,000. Since moderate unemployment will occur 30% of the time, the expected value of this occurrence is $15,000. Finally, if the city knew that unemployment would be high, it would run a job training program and receive $160,000 in benefits. Discounting this figure by its probability (.5) yields an expected value of $70,000.

Alternatively, the expected value of decisions based on perfect information is the sum of all three payoffs:

\[
\frac{1}{2} \times 20000 + \frac{3}{10} \times 50000 + \frac{1}{5} \times 140000 = 84000 + 15000 + 70000 = 86000
\]

With perfect information, the city could expect a one-off benefit of $89,000 every time this decision was made. Comparing this to the next best alternative (selecting option 3 without perfect information), the city’s payoff is $89,000 versus $51,000. The difference ($38,000) is the value of perfect information. In other words, Ragnall should purchase the forecast because its cost ($25,000) is less than its value ($38,000).
The United States could expect to have 5150 remaining warheads if this option is pursued.

The remaining expected values are presented on the truncated tree in Figure 21.2. You may wish to calculate these expected values yourself to gain some practice with decision trees.

Once the expected values are calculated, the decision to deploy the Cruise missile is easy. Simply select the option that yields the greatest expected value. In Cases 1, 3, and 4, the Cruise should be deployed, because this option has the greatest expected value. Only in Case 2, in which the MX is deployed but the Backfire is not, should the United States not deploy the Cruise. These decisions reduce the decision tree to the tree shown in Figure 21.3.

For the expected value calculated previously and the assigned probabilities, the Soviet decision to deploy the Backfire can be reduced to expected values of...
warheads remaining. For the Deploy MX option, the expected value is
\[(7 \times 5150) + (3 \times 5420) = 3605 + 1626 = 5231\]

For the Do Not Deploy option, the expected value is
\[(4 \times 5950) + (6 \times 5320) = 2380 + 3192 = 5572\]

According to the information presented, the United States should not deploy the MX missile. Then, no matter what the Soviets do regarding the Backfire bomber, the United States should deploy the Cruise missile. These two decisions maximize the expected number of warheads available for a second strike.

Decision trees often get more complex than the ones presented here. In many circumstances, so many options must be considered that only a computer can solve the resulting trees. Any manager or policy analyst who is basing a decision on a decision tree must remember that the key to using decision trees is to set up a tree that accurately reflects the real world. If all the probabilities and the payoffs are correct, the solution is easy. If they are not correct, the tree is less useful. Managers and analysts are paid to design acceptable decision trees where they are appropriate. Once this is done, the decision tree can be solved by a technici

**Exercise 24.3**

**Decision Table for Greasum**

<table>
<thead>
<tr>
<th>Greasum’s Options</th>
<th>Federal Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fund</td>
</tr>
<tr>
<td>Write grant</td>
<td>$100K</td>
</tr>
<tr>
<td>Do not write grant</td>
<td>$5K</td>
</tr>
</tbody>
</table>

Notice that the optimal decision for Greasum depends on what the federal government does. If the federal government funds the grant, Greasum should apply for the funds. If the federal government will not fund the grant, Greasum would be better off not applying and trying to fund the Title I grant. Since the probability that the federal government will fund the grant is unknown, Greasum cannot unambiguously decide whether to submit the grant.

Decisions under uncertainty can be resolved through a variety of decision strategies. The five most common strategies are discussed next.

**STRATEGY 1: THE BAYESIAN APPROACH**

Bayesian statistics believe that subjective judgments ought to be incorporated into any statistical analysis for which objective assessments are not available. In the present situation, if Greasum’s analyst were a Bayesian, the analyst
would urge Gressum—on the basis of her experience, knowledge, and intuition—to assign a probability that the federal government will fund the halfway house grant. After some thought, Gressum believes that the probability that the federal government will fund the halfway house grant is 2; this means that the probability of not funding is 8. A Bayesian would then use these probabilities to calculate expected values for both of Gressum's options.

write grant: 
\[ (2 \times 100K) + (8 \times -5K) = 20K - 40K = -20K \]

do not write grant: 
\[ (2 \times 0K) + (8 \times 25K) = 0K + 200K = 200K \]

Using these expected values, Gressum should not write the grant, but rather, should concentrate her efforts on the Title I training grant.

**STRATEGY 3: THE INSUFFICIENT REASON APPROACH**

The principle of insufficient reason attempts to define order from uncertainty. If Gressum has no idea whether the federal government will fund the grant and has no idea whether the probability is large or small, the principle of insufficient reason holds the best estimate of the probability of one of two events is 50%. In other words, if we have no way of establishing otherwise, we should assume that events are equally probable. (If three events were involved, the principle of insufficient reason would offer equal probabilities of 33.33%.) With equal probabilities, expected values can be calculated for each option:

write grant: 
\[ (5 \times 100K) + (5 \times -5K) = 50K - 25K = 47.5K \]

do not write grant: 
\[ (5 \times 0K) + (5 \times 25K) = 0K + 125K = 125K \]

Under the principle of insufficient reason, Gressum should write the grant.

**STRATEGY 3: THE MAXIMUM PRINCIPLE**

The maximum principle was discovered by a pessimist. Under maximin, Gressum should assume the worst that could happen. Examining the payoff table (Table 21.6), Gressum sees that the worst that could happen if she wrote the grant would be that the federal government would not fund it and that she would lose $5000 in expenses.

**TABLE 21.6**

<table>
<thead>
<tr>
<th>Gressum's Options</th>
<th>Federal Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fund</td>
</tr>
<tr>
<td>Write grant</td>
<td>$100K</td>
</tr>
<tr>
<td>Do not write grant</td>
<td>$0K</td>
</tr>
</tbody>
</table>

If Gressum does not write the grant, the worst that could happen is that the federal government will fund the grant. In this case, Gressum would receive $100K. Maximin then requires that the worst cases be compared and the best of the worst cases be selected.

The best option, according to this criterion, is clearly to not write the grant and thus not lose any money. (Maximin gets its name from the logic it uses; the decision maker selects the minimum of the minimum payoffs.)

**STRATEGY 4: MINIMAX EXPECTED**

The minimax regret principle is based on opportunity costs. It asks the question, if we decide a certain way and make the wrong decision, what opportunity has been lost? For example, if Gressum does not write the grant and the grant would have been funded, Gressum would lose $100,000 in opportunity costs. If she writes the grant and it is funded, she loses nothing in opportunity or regret costs. If the grant is not funded, writing the grant is associated with an opportunity cost of $50,000, not writing the grant has no opportunity costs. Combining these opportunity costs into a single decision table, we get the results of Table 21.6.

**TABLE 21.6**

<table>
<thead>
<tr>
<th>Gressum's Options</th>
<th>Federal Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fund</td>
</tr>
<tr>
<td>Write grant</td>
<td>$50K</td>
</tr>
<tr>
<td>Do not write grant</td>
<td>$100K</td>
</tr>
</tbody>
</table>

Next, the maximum opportunity cost associated with each alternative is noted:

**Options**

| Write grant | $50K |
| Do not write grant | $100K |

The minimax regret principle then designates the minimum opportunity cost as the best alternative. In this case, the best alternative is to write the grant, because the greatest opportunity cost is only $50,000 versus $100,000 for the other.
alternative. (Minimax regret gets its name because one selects the minimum of the maximum regrets.)

**STRATEGY & MAXIMAX**

Maximax is a decision principle supported by the same people who, in April, bet that the Chicago Cubs will win the World Series. Maximax is the principle of the optimist. The decision maker takes the position that the best will happen. In this situation, Gressum will assume that if she wins the grant, it will be funded and she’ll write the grant, the TiDDI 1 project will be funded (a gain of $235,000). One simply computes the best that can happen with each option and selects the maximum maximum. In this case, Gressum would write the grant to get the $100,000 project funded.

**HOW TO DECIDE?**

Decision rules are everywhere, but which to use? In a situation of uncertainty, should you select Bayesian, insufficient reason, maximin, minimax regret, or maximax? That decision should be based on two factors. First, how important is the decision? U.S. defense planners favor the maximin rule. They assume that the worst will happen and plan accordingly. That way, if less than the worst happens, the U.S. defenses are in better shape than necessary. In such a life-and-death situation, pessimism may be the best decision rule. If the decision has few consequences (such as, which of three grants we should apply for in our space time), then maximax might be more appropriate. If the manager has confidence in his or her subjective probability estimates, then perhaps Bayesian decisions would work best. Second, the appropriate decision rule depends on the manager’s attitude toward risk. Some of the decision rules require greater risks (maximax) in hopes for greater payoffs; other rules are conservative. A manager who thrives on risk may select one rule, whereas a risk avoider may select another. The appropriate decision rule, therefore, is a management decision.

**GAME THEORY**

Often in a managerial or policy situation, states of nature are not naturally occurring; rather, they result from decisions made by others. When the other actor seeks to maximize his or her position and these actions affect us, a game situation exists. Game theory was developed to analyze competitive situations.

**ZERO-SUM GAMES**

The simplest game is the two-person, zero-sum game. A two-person game obviously involves two people, and a zero-sum game is one in which one player’s gains are the other person’s losses, and vice versa. An illustration is in order.
assumes that Melvin is out to hold down employment (which he is) and decides to act on a worst-case basis and use maximin. Under maximin, Joe would get one employee under regular procedures and two under affirmative action. He opts for affirmative action. Melvin also applies maximin since he distrusts Joe. Under maximin, Melvin could hold Joe to a maximum of four employees with regular procedures, or to a maximum of three if he uses temporary procedures. Melvin decides on temporary procedures. The result of the two independent decisions means that Joe will get three employees of every five applicants sent to Melvin. Joe cannot improve this record, since he would only get one employee if he tried regular employees and if Melvin (rationally) stayed with temporary procedures. Melvin, however, notices that he could hold Joe to two employees if he invoked regular procedures. Melvin also sees that if he always had regular procedures, Joe would use regular employees and hire four of every five persons. So Melvin begins to act randomly, sometimes using regular procedures, sometimes temporary ones. Joe continues his affirmative action strategy and gets only an average of 2.5 employees every time. Melvin has financed Joe out of employee cut out of every ten. Melvin can do this because the present game does not have a saddle point—a single solution that yields the optimum for both actors. Can Joe construct Melvin's randomness? No, because if Joe occasionally sent people over as regular employees, half of the time four would be hired and half of the time one would be hired, for an average of 2.5. In this situation, random action is a rational choice, but only for one of the actors.

**POSITIVE-SUM GAMES**

A city police union must decide whether it should push for moderate demands or make strong demands on the city. The city manager must decide whether to settle quickly or to tolerate a strike. If the city settles quickly, the police will do better if they have high demands. If the city tolerates a strike, high demands reflect unfavourably on the city, and it will do less well. Although this situation looks much like the zero-sum game described before, the city has the option of turning it into a positive-sum game in which everyone benefits. Let us say that the police union contract expires in an election year. As a result, the mayor does not want a strike and tells the city manager to avoid one. He also tells the city manager to hold down salary costs. The manager has an idea. He tells the union that if it will moderate wage demands, he will give the union more than it wants in pensions. This offer translates the game into a positive-sum game. The union is happy because it received everything it asked for, although not all of it in wages. The manager avoids a strike; and since the pensions will cost future managers rather than his administration, the manager is happy. Neither participant loses; hence the game is positive-sum. (The only losers are future city managers and the taxpayers.)
The EEOC then fines both the union and the company $10,000. Why is this a prisoner's dilemma? For a simple reason: had the union and the company talked to each other, they could have both said nothing. This action would cost each $3000 rather than $10,000. Therein lies the dilemma. Cooperation would make both the union and the company better off, but rationality leads to a less than optimal solution.

A manager faced with a prisoner’s dilemma should seek to turn the game into a positive-sum game through collusion with the other players. If the players trust each other, then all parties will be better off than if they were caught on the horns of the dilemma.

A FINAL COMMENT

This section limits its discussion to two-person games. Game theory has developed beyond simple two-person games to three, four-, and n-person games. Although these topics are too advanced for this introductory text, when gamelike situations exist in the real world that are not just two-person games, more complex models should be used. Consult any management science text for a treatment of more complex games (see Singleton and Tyn dall 1974).

**CHAPTER SUMMARY**

Decision theory is a set of decision approaches used to resolve managerial problems. For ideal conditions, five steps have been identified in the rational decision-making procedure. First, identify the problem. Second, specify goals and objectives. Third, specify all available alternatives. Fourth, evaluate the alternatives in light of the goals. Fifth, select the optimal alternative.

When all the crucial aspects (states of nature) of a decision are known, decision making takes place under certainty. When the environment of a decision can only be assigned probabilities, then decisions are made under risk. Decisions under risk involve decision tables, payoff tables, cost-benefit calculations, probability calculations for each state of nature and expected value computations. In very complex situations, decision analysts often represent decisions under risk with decision trees rather than with a simple payoff table.

When nothing is known about the environment, decision making under uncertainty uses one of several strategies. Bayesian probabilities incorporate subjective judgments into the statistical analysis. The principle of insufficient reason attempts to define order from uncertainty. Under the maximin principle, the decision maker selects the maximum of the minimum payoffs (the best of the worst). Using minimum regret, one selects the minimum of the maximum regrets. Under the maximax principle, the decision maker selects the maximum of the maximum payoffs (the best of the best).

Often in a managerial situation, the states of nature result from decisions made by others. Game theory was developed to analyze these competitive situations. In a zero-sum game, one player’s gains are the other’s losses, and vice versa. In a positive-sum game, everyone benefits.

**PROBLEM 11**

The department of social services is considering three programs to voca tional training for the handicapped: a contract for teaching the unskilled labor skills provided by a private vendor (program A); a proposal to train the handicapped as computer operators, provided by the state data processing center (program B); and a program to teach clerical skills, provided by a local business school (program C). Three states of nature affect the success of each program. State A is a pool of handicapped in which less than 20% are severely disabled; state B is 20–40%, severely disabled; and state C is more than 40% severely disabled. The accompanying payoff table shows the number of handicapped who could be successfully rehabilitated in a year with the three programs and the three states of nature.

<table>
<thead>
<tr>
<th>Program</th>
<th>State of Nature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>A</td>
<td>20</td>
</tr>
<tr>
<td>B</td>
<td>40</td>
</tr>
<tr>
<td>C</td>
<td>30</td>
</tr>
</tbody>
</table>

(a) Using the maximin criterion, what program would you select and why?
(b) Using the maximax criterion, what program would you select and why?
(c) Is maximin or maximax the more appropriate criterion in this case?

21.2 Refer to Problem 7.1.
(a) With minimax regret, what is the best decision?
(b) Using the principle of insufficient reason, what program would you select and why?

21.3 Refer to Problem 21.1. You are a Bayesian and your analyst tells you that he believes that the probability of each state of nature is .6 for A, .2 for B, and .2 for C.
(a) With this information, what is the best program?
(b) How much would the expected value of rehabilitated cases be affected by a survey that told you the exact number of severely disabled?
(c) Would you pay $30,000 for such a survey?