Problem Solving

Although most people have heard the term problem solving used, most do not have a real, working definition of what it really is. The first thing to define is what a problem is. A problem exists when you have a goal or objective and you do not know how to reach it. If we knew how to reach it, it wouldn't be a problem. To solve a problem, then, simply means finding a way to reach your goal or objective. In this section, we will deal with so-called tame problems, which are those problems that can be defined clearly, have a solution and do not create subsequent problems when they are solved.

There are numerous methods and techniques that can be used to reach your goal. However, there are aspects that are common to how we solve problems regardless of the technique. The first step is to mentally represent what the problem really is, then set a goal to accomplish and, finally, consider the actions you can take to reach your goal. The pioneers of problem solving, Newell and Simon, call this the problem space and defined the nature of problem solving as a search. So, a crucial part of problem solving is our ability to represent the problem, imagine possible solutions and evaluate whether they can take us in the direction of our goal or not before acting.

Most problem solving techniques expand these three phases into five or six steps:

- Define the problem;
- Analyze the problem;
- Identify solutions;
- Choose a solution;
- Create a plan of action;
- Implement the plan.

Many times we run into difficulty because we are unable to clearly define the problem, or we can't break it down into a series of problems. At other times, we can't generate a solution to bring us closer to our goal because we lack the correct strategy. Often we are unable to evaluate whether the actions we plan on taking will lead us in the right direction. There are many barriers to problem solving, which will be examined more closely later.

Stategies

There are numerous strategies for solving problems, such as reasoning by analogy, means-end analysis, hill climbing, trial and error, inductive reasoning, deductive reasoning, forming subgoals and changing the way the problem is represented.

Reasoning by Analogy

Reasoning by analogy is simply using a solution that we have found to work and applying it to a problem that is similar or analogous. The most famous example of this is Duncker's radiation problem which can be solved by analogy using the Attack-Dispersion story.

Duncker's radiation problem

Suppose you are a doctor faced with a patient who has a malignant tumour in his stomach. It is impossible to operate on the patient, but unless the tumour is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumour. If the rays are directed at the tumour at a sufficiently high intensity the tumour will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumour will also be destroyed. At lower intensities, the rays are harmless to the healthy tissue but they will not affect the tumour either. What type of procedure might be used to destroy the tumour with the rays, and at the same time avoid destroying the healthy tissue?

Most people find it difficult to come up with a solution to the problem, but this second problem is easier to solve.

Attack-Dispersion

A small country was ruled from a strong fortress by a dictator. Various roads led to the fortress through the countryside. A rebel general vowed to capture the fortress. The general knew that an attack by his entire army would capture the fortress. He gathered his army at the head of one of the roads, ready to launch a full-scale direct attack. However, the general then learned that the dictator had planted mines on each of the roads. The mines were set so that small bodies of men could pass over them safely, since the dictator needed to move his troops and workers to and from the fortress. However, any large force would detonate the mines. How can the rebel general capture the fortress.

It is fairly simple to see that the rebel general can split up his troops and send them by different routes to attack the fortress. By analogy, then, the doctor can use more than one ray from different angles and at lower intensity to destroy the tumor without damaging the healthy tissue.

Trial and Error

Trial and error is simply trying different solutions until you find one that works. This type of strategy is practical only when the number of possible solutions is relatively small. In addition, it does not guarantee that you found the optimal solution to the problem. It just means that you found one solution. A simple example of trial and error is trying to figure out which button on the dashboard of your newly rented car switches on the headlights. You might press all the buttons until you find the right one.

Hill-climbing

Hill climbing is kind of similar to trial and error. You pick what appears to be the most direct route to the goal at each step. If this choice proves to be incorrect, you choose an alternative method to see if it achieves the goal faster. This method is appropriate only for certain tasks though. One example of a type of problem that requires the hill-climbing method is a maze. The

maze contains an entrance and an end. Each line within the maze becomes an obstacle between the initial state and the goal state.

Means-end Anlysis (MEA)

MEA is a strategy to control search in problem-solving. Given a current state and a goal state, an action is chosen which will reduce the difference between the two. The action is performed on the current state to produce a new state, and the process is recursively applied to this new state and the goal state. A classic example is the missionary and cannibal problem.

Problem

On one bank of a river are three missionaries and three cannibals. There is one boat available that can hold up to two people and that they would like to use to cross the river. If the cannibals ever outnumber the missionaries on either of the river's banks, the missionaries will get eaten. How can the boat be used to safely carry all the missionaries and cannibals across the river?

Solution

Two cannibals take the boat, so that one of them drops off a cannibal on the other bank. So, one of the cannibals goes back to the other bank and picks up another cannibal. He drops him off on the other bank. So, there are two cannibals on the other bank. So, now the cannibal in the boat goes back and he gets out of the boat and two missionaries get on. Both get off on the other bank and one of the cannibals gets into the boat. He picks up the last missionary and brings him to the other bank. The missionary gets off and the cannibal returns and picks up the final cannibal. Both get off at the other bank.

Deductive Reasoning

Deductive reasoning is where a conclusion is drawn from a set of general premises or statements. If the premises are true, then the conclusion must be true.

Example

If the premises "All mammals are warm blooded" and "A dolphin is a mammal" are true, then the conclusion "A dolphin is warm blooded" must also be true.

Inductive Reasoning

Inductive reasoning is where a general conclusion is drawn from examples. In this case, the conclusion is likely to be true, but it is not guaranteed.

Example

Given the premise "All the cars I have ever seen have four wheels," One might conclude, "All cars have four wheels."

Forming Subgoals

To form subgoals you come up with intermediate steps to solve a problem. This serves to simplify the problem.

Example

Jacob is presented with the following analogy problem: “School is to student as association is to ____.” Jacob’s subgoal is to define the relationship between “school” and “student.” Once he reaches this subgoal, he can easily find the answer, “member.”

Changing the Way a Problem Is Represented

Changing the way that a problem is represented can make a problem easier to solve.

Example

The problem is how to inform guests at a wedding reception of which table they are supposed to sit at. If you simply put up a list, people will have a hard time finding their seat assignments. Instead, if you use a seating chart and place a number of charts in strategic places, the problem of finding seats is no longer a problem.