1 Techniques for Solving Problems

In life we encounter problems every day, from deciding what to wear in the morning to planning a trip for summer vacation. Some problems may be easier to solve than others because we have a preference (I love to eat eggplant parmesan. So, where should we eat tonight?) while others may be very taxing (I have only one stick of bubble gum and two friends. Who will get it?).

This chapter will give you the tools to become a great problem solver. We will look at formalizing the steps you can take to systematically arrive at a solution, and how you can use these skills to program a computer.

1.1 Steps in solving a problem

While every problem is unique, there are some core steps that you can follow to help you break down and solve any situation. The steps that are outlined here will be used throughout the entire text for you to frame your programming solutions.

After you have read or listened to the problem presented,

1. Identify your **input.**
   Input is the essential information that a program needs to solve the problem. The input may be given by an outside source (like the person using the program) or default values given by the programmer.

2. Identify the **goal** or **objective.**
   The goal is where you define your end result. This is a description of when you know your problem has been solved and your objectives have been met. Sometimes you may have more than one goal, so list each goal clearly.

3. Create a list of **tasks** to achieve your objective.

These are the steps required to reach your goal. Make sure you enumerate your steps in order for clear execution. Also make sure each step is descriptive and clear. Your list of tasks will result in your goal from step 2.

When you have finished your tasks, make sure that you have answered the problem and met your goal(s). This is probably the most important part of the steps, but the easiest one to forget. Remember if your steps (from part 3) don't lead to your goal (from part 2) then you didn't solve the problem and you should start back at step 1.

1.2 Motivating example

Juanita is planning a trip to visit the Grand Canyon. Since she lives in Seattle, Washington, she is concerned about the cost of gas needed to make the trip. Using online mapping software, she calculated that it will take 1,224 miles to reach the Grand Canyon. Traveling on the highway, Juanita's car gets 18 miles per gallon (*MPG*). Estimating that the average cost of gas is $4.20 per gallon (*CPG*), calculate how much money it will cost for her to travel to the Grand Canyon. Using the equation below, you can calculate the cost of travel by distance divided by MPG times CPG:

$$cost = distance \div MPG \times CPG$$

To solve this with our problem solving steps from section 1.1, we first need to identify the input (step 1):

distance: 1224 miles
MPG: 18
CPG: $4.20

Now we can state our goal (step 2):

Find the cost

Lastly we list our tasks to reach our goal (step 3):

1. Plug the input(s) into the cost equation
2. Return the cost

Now that the problem is broken down into some clear steps, we can execute the tasks to reach our goal.

cost = 1224 / 18 * 4.20
cost = $285.60

Self-Check 1.1:

What is the purpose of the second step in solving a problem?

1.3 Programming Skills

One of the main goals of this textbook is to teach you the skills to become a good programmer. Given below, are some of the terms which a person needs to know in a programming environment.

A **programmer** is a person who creates programs that solve a problem using the computer.

A **program** is a sequence of steps that a computer understands and executes.

A **programming language** is a notation used to write instructions into a computer.

A **computer** is a logical device, created from silicon and metal, which runs on electricity.

An **algorithm** is a set of instructions designed to complete a task.

A **bug** is an error in a program.

Debugging is the process of removing errors, testing and revising a program to make sure that it performs as expected.

We encounter problems everyday, many of them too complex to solve without help. By defining problems for a computer using the problem-

solving components of inputs, goals, and tasks, we can start the process of programming a computer to assist us in finding solutions.

Programs have to satisfy clear rules so that a computer knows the exact specifications of the problem and solution. The rules, or **syntax**, that you use to program in will differ based on the type of programming language that you are using. In this book we will be using a programming language called **Python** to apply the lessons you are learning. We will discuss more about programming techniques and Python in Appendix A and from Chapter 3 on.

Key Terms

Algorithm	Objective
Bug	Programmer
Computer	Programming language
Debugging	Python
Goal	Tasks
Input	Syntax

Exercises:

For each of the problems below, following the problem solving steps.

1) Reno, Nevada is a desert city supporting a population of over 180,480 people (in the 2000 census). The large population and desert location makes water a treasured resource. Many citizens of Reno do not own their own swimming pool because water is so dear; instead they visit the public swimming pools. If the city charges 1.2 cents per cubic feet of water, calculate the cost the city pays for water needed to fill a typical public swim pool if the pool is 20 feet wide, 30 feet long and 10 feet deep. Use the following equations:

   *Volume in cubic feet = length * width * height*
   *Cost = cost per cubic feet * Volume in cubic feet*

2) Describe how to open a bag of pretzels. Your tasks will be the actions to perform to reach your goal. Make sure you state your assumptions (i.e., what is the position of the bag and the hands). Try to limit your verbs you use in your tasks to *reach*, *grasp*, and *pull away*.

3) Jimmy works at the local air force base. On Wednesday, Jimmy worked from 8:12 hours until 16:38 hours with a lunch break from 12:02 hours until 12:24 hours. Calculate how long Jimmy worked on Wednesday.

Time worked = _____

4) Describe how to sharpen a pencil using an electric pencil sharpener. Your tasks will be the actions to perform to reach your goal. Make sure you state your assumptions (i.e., what is the position of the pencil and the hand). Try to limit the verbs that you use in your tasks to *move, push, wait, remove, judge, toward, pull, go to*.

5) Describe how to fill a glass with water. Your tasks will be the actions to perform to reach your goal. Make sure you state your assumptions (i.e., what is the position of the glass, sink and hand). Try to limit the verbs that you use in your tasks to *move* and *hold*.

Projects:

1. Describe how to make a peanut butter and jelly sandwich. Try to limit the number of verbs that you use to less than 10.

2. You have decided to repaint the four walls of your living room and need to know how many gallons of paint to buy. There is one window and one entrance to the room. Describe how you would calculate the number of gallons of paint needed taking the description of the room into account. Assume one gallon of paint covers 350 square feet.

   Hint: *Square feet = Length * Width*

3. Describe how to open a Kit-Kat bar wrapped in packaging . Your tasks will be the actions to perform to reach your goal. Make sure you state your assumptions. Try to limit the verbs that you use in your tasks to *tear* and *hold*.

4. Describe how to organize five books on a bookshelf in alphabetical order by author. Your tasks will be the actions to perform to reach your goal.

Make sure you state your assumptions. Try to limit the verbs that you use in your tasks to *pick-up* and *place*.

5. Describe how to blow up a rubber balloon. Your tasks will be the actions to perform to reach your goal. Make sure you state your assumptions. Try to limit the verbs that you use in your tasks to *blow, breathe* and *hold*.

   For extra credit, describe how to create a balloon animal in the shape of a dog. Your tasks will be the actions to perform to reach your goal. Make sure you state your assumptions. Try to limit the verbs that you use in your tasks to *blow, breathe, twist* and *hold*.

Answers to self-check problems:

1.1: The goal step states the end result that is accomplished via your tasks.