

Session 3: Problem Solving Process

3.1 Introduction

In the previous session, you learnt how to create a solution to a real-world puzzle and you had a look at the general strategies of problem solving. A similar problem – solving process is used to create a computer program. A computer program also is a solution, but one that is implemented with a computer. To solve problems that require a computer solution, computer programmers should follow the following steps:

1. Analyze the problem
2. Plan the algorithm
3. Desk-check the algorithm
4. Code the algorithm into a program
5. Desk-check the program
6. Evaluate and modify (if necessary) the program

3.1.1 Step 1 - Analyze the Problem

You cannot solve a problem unless you *understand* it, and you cannot understand a problem unless you *analyze* it – in other words, unless you identify first what is required of you from the problem and also identify its important components. We will discuss two ways of how to understand the problem:

1. Rewrite the problem
2. Identify the important components of the problem

1. Rewrite the problem

Given a computer problem to solve, the first approach to solving that problem is make sure you understand the problem in terms of its needs. To do so, we to rewrite the problem such that we have a list of what is required of us to solve the problem.

We look at the problem statement, sentence by sentence, list the sentences. After which then sentence by sentence look at verbs in each sentence which guides on what the program will do; be sure to list them one by one. This way then we will know what is expected of us in terms solving the problem. To illustrate this step, we will use the following problem statement shown in Figure 3-1 below:

Mahir Athman wants a program that calculates and displays the amount he should tip a waiter at a restaurant. The program should subtract any liquor charge from the total bill and then calculate the tip (using a percentage) on the remainder.

Figure 3-1: Problem Specification for Mahir Athman

As shown in Figure 3-2, there are two sentences in this problem specification:

1. Mahir Athman wants a program that calculates and displays the amount he should tip a waiter at a restaurant.
2. The program should subtract any liquor charge from the total bill and then calculate the tip (using a percentage) on the remainder.

Figure 3-2: Extraction of Sentences from Mahir Athman problem

From these two sentences, we can now attempt to come up with the initial requirements for our problem. Remember this step of specifying help us to understand the problem by helping us know what is required of us to do say that we have solved the problem. The first attempt of the list of requirements are:

1. Calculate and display the amount of tip to be paid.
2. Subtract any liquor charge from the total bill and then calculate the tip.

You will realize that both requirements are compound statements in nature: like requirement 1 above talks of *calculate and display...* these are two requirements combined together. You cannot calculate and display at the same time, for simplicity sake separate the two.

1. Calculate the amount of tip to be paid.
2. Display the amount of tip to be paid.

Requirement 2 also is a compound statement in nature it talks of *subtract ... and then calculate the tip* can be broken down as follows:

1. Subtract liquor charge from total bill to get the amount to be charged tip (call this amount as 'tip amount bill').
2. Calculate the tip as a percentage of tip amount bill.

How if we combine the two sets of requirements, we will have the following requirements as shown in Figure 3-3 below:

1. Calculate the amount of tip to be paid.
2. Display the amount of tip to be paid.
3. Subtract liquor charge from total bill to get the amount to be charged tip (call this amount as 'tip amount bill').
4. Calculate the tip amount as a percentage of tip amount bill.

Figure 3-3: Initial attempt on Requirements Specification for Mahir Athman problem

Remember, in our discussion about the class puzzle we learnt about how restate the problem to enable us understand what the problem is. In so doing, a solution can be easily found; however, without understanding what you want to solve, it will be a nightmare to solve a problem you

do not understand. Understanding the problem from your own perspective is key to problem – solving especially in programming.

2. Components of the Problem

The two important components of any problem are the problem's output and its input. The output is the goal of solving the problem, and the input is item or items needed to achieve the goal.

When analyzing a problem, you always search first for the output data items and then for the input data items. From our complete requirements list (see Figure 3-3 requirement 2), we easily identify the output by searching for an answer to the following question: *What does the user want to see displayed on the screen, printed on paper, or stored in a file?* The answer to this question typically is stated as nouns and adjectives in the requirements specification. For example, the requirements specification indicates that the user wants to see the amount of the waiter's tip displayed on the screen; therefore output data item is the tip. In this context, the word tip is a noun.

After determining the output, you then determine the input. From our requirements list in Figure 3-3, it is not easy to identify the input data items; reason, it assumed that the user has the total bill in his/her hand. From that assumption, we can now easily search for an answer to the following question: *What information will the computer need to know to display, print, or store the output items?* As with output, the input typically is stated as nouns and adjectives in the requirements specification. When determining the input, it helps to think about that information that you would need to solve the problem manually, because the computer will also need to know the same information. In this case, to determine the tip, both you and the computer need to know the total bill, liquor charge, and the tip percentage; these items, therefore, are the input. The liquor charge is specified in the total bill, whereas the tip percentage must specified in restaurant policy manuals. In this context, *total*, *liquor*, and *tip* are adjectives, while *bill*, *charge*, and *percentage* are nouns.

From the requirements stated in Figure 3-3 above, requirement 3 and 4 specify the processing of the input data items to achieve the problems output. A **processing data item** represents an intermediate value (it is neither input nor output) used in the processing input data items into output. The processing typically involves performing one or more calculations using the input items. In this case, the tip is calculated by subtracting the liquor charge from the total bill and then multiplying the remainder by the tip percentage. For avoidance of confusion the first value that we obtain as the difference we will call it tip amount bill and second value which is then product of tip amount bill and tip percentage we will call tip. This completes the analysis step for Mahir Athman problem. Figure 3-4, below depicts that data items for Input, Processing and Output of the Mahir Athman problem.

Input items	Processing items	Output items
total bill	tip amount bill	tip
liquor charge	tip	
tip percentage		

Figure 3-4: Input, Processing and Output data items for the Mahir Athman problem

Exercises

Write the requirements and identify the three data items for each of the following problem specifications:

- a) The computation for payment of part time teaching at the Technical University of Mombasa is based on the number of hours a lecturer has taught and rate per hour. The gross pay is computed as a product of number of hours worked per semester and rate per hour, withholding tax is computed as 30% of the gross pay and the net pay is computed as a difference of the withholding tax from gross pay.

The administrator wants you to write a program that computes the gross pay, withholding tax and net pay. The program should also display the hours worked, rate per hour, gross pay, withholding tax and net pay.

- b) James Njuguna is interested with a program that computes the corresponding Value Added Tax (VAT) of a product given the product price. Then the program should also compute the selling product price after tax and display the product price, selling price after tax, and its corresponding VAT. Assume a 16% VAT rate.