Swinburne University of Technology Sarawak

COS10009 Introduction to Programming – Semester 1 / 2018

Arithmetic Expression & Operators – (Lab 02)

Core Task 1

To Do

Integer Division and Truncation Errors

Open the "integerTrouble.c" program with Quincy. Compile, link, run it. Note the arithmetic errors, and how the calculations using doubles produce the correct answers.
(a). Modify the integer division code so that all integer variables are cast as doubles.
(b). Replace the formatting string %i with an appropriate specifier.

Core Task 2

To Do

Writing algorithms to solve problems

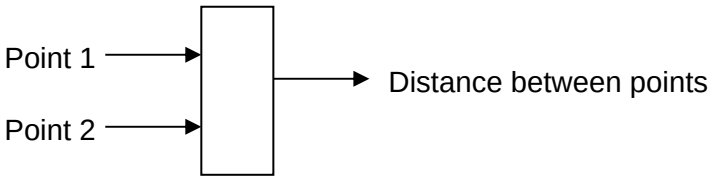
5-Step of Problem Solving

1. Problem Statement

Compute the straight-line distance between two points in a plane.
(The first step is to state the problem clearly. It is extremely important to give a clear, concise problem statement to avoid any misunderstandings)

2. Input/Output Description

The second step is to carefully describe the information that is given to solve the problem and then identify the values to be computed. These items represent the input and the output for the problem and collectively can be called input/output.



3. Hand Example

The third step is to work the problem by hand or with a calculator, using a simple set of data. This is very important step, and should not be skipped even for simple problems. This is the step in which you work out the details of the problem solution. If you cannot take a simple set of numbers and compute the output (either by hand or with a calculator), then you are not ready to move on to the next step; you should read the problem again and perhaps consult reference material. The solution by hand for this specific example is as follows:

Let the points p_1 and p_2 have the following coordinates:

$$p_1 = (1, 5); p_2 = (4, 7).$$

We want to compute the distance between the two points, which is the hypotenuse of a right triangle, as shown in Figure 1. Using the Pythagorean theorem, we can compute the distance with the following equation:

$$\begin{aligned} \text{distance} &= \sqrt{(\text{side}_1)^2 + (\text{side}_2)^2} \\ &= \sqrt{(4 - 1)^2 + (7 - 5)^2} \\ &= \sqrt{13} \\ &= 3.61. \end{aligned}$$

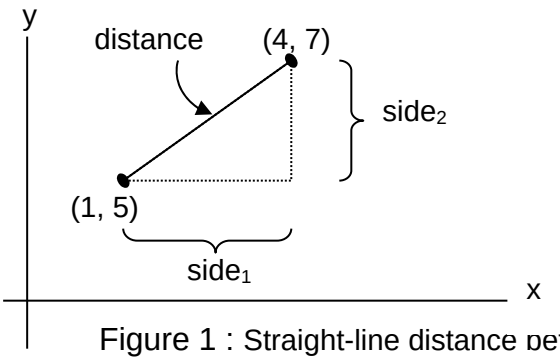


Figure 1 : Straight-line distance between two points.

4. Algorithm Development

Once you can work the problem for a simple set of data, you are ready to develop an **algorithm**, or a step-by-step outline, of the problem solution. For simple problems such as this one, the algorithm can be listed as operations that are performed one after another. This outline of steps decomposes the problem into simpler steps, as shown by the following outline of the steps required to compute and print the distance between two points:

Decomposition Outline

1. Give values to the two points.
2. Compute the lengths of the two sides of the right triangle generated by the two points.
3. Compute the distance between the two points, which is equal to the length of the hypotenuse of the triangle.
4. Print the distance between the two points.

This **decomposition outline** is then converted to C commands so that we can use the computer to perform the computations.

5. Testing

The final step in our problem-solving process is testing the solution. We should first test the solution with the data from the hand example because we have already computed the solution. When the C statements in this solution are executed, the computer displays the following output:

The distance between the two points is 3.61

This output matches the value that we calculated by hand. If the C solution did not match the hand-calculated solution, then we should review both solutions to find the error. Once the solution works for the hand-calculated example, we should also test it with additional sets of data to be sure that the solution works for other valid sets of data.

The set of steps demonstrated in this example are used in developing all the programs that follow.

Core Task 3

To Do

For this task you can choose to implement one of the following two programs:

Option 1: Investment Calculator

With compound interest, interest is paid on the principle and any interest received during the period of the investment. For example, if you invest $1000 at 15% interest then in the first year you will receive $150 interest. This interest is then added to your investment, and in the second year you will receive $172.50 interest (15% of the $1150). The following formula can be used to calculate the amount of interest an investment will receive over a period of time.

$I = P (1 + i)^n — P$

For example, after 5 years our $1000 invested at 15% will have accrued $1011.375 in interest.

$I = P (1 + i)^n — P$
$I = 1000 * (1 + 0.15)^5 — 1000$
$I = 1011.357$

1. Create a program named InvestmentCal, which will read and write values from the consol.
2. Declare variables for principle, years and rate.
3. Get the user to enter a principle, rate and duration, then the program will output the interest earned from the investment.
4. Write out 'Bank A', and calculate the interest based on the same amount of principle and duration of investment, at 3.5% (0.035).
5. Write out 'Bank B', and calculate the interest based on the same amount of principle and duration of investment, at 4.5% (0.045).

Hint: The user is expected to enter the interest rate in percentage (so 15 for 15%), thus the program should divide the input by 100.

Option 2: Air Speed Velocity

Instructions For this task you will create a program to answer the age old question "What is the airspeed velocity of an unladen swallow?" Watch this video if you are uncertain of the importance of this information.

The air speed velocity of a bird can be calculated using an equation based on the Strouhal Number. From this information we can determine that the air speed velocity of a bird (U) can be calculated from the frequency (f) at which the bird beats its wings multiplied by the amplitude (A) of each wing stroke, divided by the Strouhal Number (s). This is shown in the following equation:

$$U = \frac{fA}{s}$$

For example: A Zebra Finch beats its wings at a frequency of 27hz (f). The amplitude of this 1 stroke is 11cm (A). If we assume a Strouhal Number of 0.33 for this flight we get an air speed 2 (U) of 9 meters per second, as shown in the following steps:

U = f A / s
U = 27 * 0.11 / 0.33
U = 9 m/s

1. Create a program named AirSpeed, which will read and write values from the console.
2. Declare a constant for the Strouhal Number with the value 0.33. In the code use UPPERCASE for the constant. e.g.: const double STROUHAL_NUM = 0.33;
3. The program should then ask the user to enter the name of swallow, and the frequency and amplitude. Then, write the name of the swallow and the resulting velocity to the console.
4. Write out 'African Swallow', and calculate the air speed based on a frequency of 15hz and amplitude of 21cm, and write the resulting velocity to the console.
5. Write out 'European Swallow', calculate the air speed based on a frequency of 14hz and an amplitude of 22cm, and write the resulting velocity to the console.

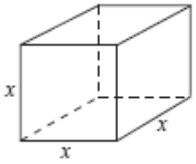
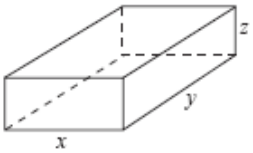
Vital Task

To Do

Area and Volume

Surface area is the sum of the areas of all the faces of the solid object. It is measured in square units. Volume is the number of cubic units that make up a solid object. It measures how much space an object occupies. (More Info)

For example, the formula for calculating area and volume for cube and cuboid:

Cube		Volume = x^3 Surface area = $6x^2$
Cuboid		Volume = xyz Surface area = $2xy + 2xz + 2yz$

You are required to select a solid object of any shapes, it could be cone, prisms, pyramid, cylinders, etc (except cube and cuboid), find out the formula to calculate its area and volume. Next, write a C program that will prompt for all the input that is required to calculate the area and volume of that object. The program will eventually display the area and volume of the object to the screen.

(Note: Please verify the output with your own hand execution/calculation to ensure the output from your program is correct)

Challenge Task

To Do

Number Systems

There are four basic numbering systems that are used in the human, networking, and computer science worlds. Binary, octal, decimal and hexadecimal. Decimal is the numbering system we are most familiar with, it has a base, or radix, of 10 and to us this is natural. The other systems widely in use in the networking and computer science world are binary, octal and hexadecimal.

Please refer Numeral Systems and Conversion for more details.

You are required to construct a program that prompts user to enter an 8-bit binary number, then it will be converted into decimal number and hexadecimal number as output. You may request the user to input the binary number by entering one bit at a time.

Example of program execution:

Please enter the 1st bit of your binary number (0 or 1): 1
Please enter the 2nd bit of your binary number (0 or 1): 1
Please enter the 3rd bit of your binary number (0 or 1): 0
Please enter the 4th bit of your binary number (0 or 1): 1
Please enter the 5th bit of your binary number (0 or 1): 1
Please enter the 6th bit of your binary number (0 or 1): 0
Please enter the 7th bit of your binary number (0 or 1): 0
Please enter the 8th bit of your binary number (0 or 1): 0

Output:
The decimal value of your binary number is 27.
The hexadecimal value of your binary number is 1b.

(Hints: Remember to look for the correct specifier in order to display a hexadecimal value)