Högskolan Kristianstad
291 88 Kristianstad
044-20 30 00
www.hkr.se

DT555A Programming in C

Lab 1 – Algorithm Development

Objectives and Assessment

This lab is to provide practice on algorithm development and representations in both flowcharts and pseudo codes.

It should be noted that not all tasks are required. A lab report is required and will be graded. The lab is graded in a system of U (failed), 3 (pass), 4 (good) and 5 (excellent).

You need to solve 2 tasks in this lab. Based on your background, time and interests, you can choose grade 3 or grade 5 tasks. If you choose grade 3 tasks and have written a good lab report, your grade will be set to be 4; if you choose grade 5 tasks, and the lab report is not well written, your grade will be set to be 4.

Implementation

This lab is mandatory and individual. The discussion with your classmates are promoted. But the copy-and-paste is not allowed.

- You should find time yourself and develop algorithms to solve the problems, represent your algorithms in flowcharts and pseudo-codes, and write a lab report, based on the lab report template, found in the folder “labs”.
- You need to upload the report in due date to be graded within 2 weeks after due date.

Grade 3-- Task 1 Computer Assisted Instruction (CAI)

The use of computers in education is referred to as computer assisted instruction (CAI). Write an algorithm that will help a primary school student practice additions (with numbers in the range 0—100). Your algorithm will generate an addition question and ask the student to give the answer. For example, your algorithm would print a question like

    How much is 6 plus 7?   Answer =

The student then enters the answer. Your algorithm checks the student's answer. If it is correct, the algorithm prints "very good!" and the algorithm stops. If the answer is wrong, it prints "No. Please try again." And then let the student try the same question again repeatedly until the student finally gets it right. Then the algorithm stops.

The key to this CAI algorithm is how to generate a question. We suppose that you can use the following pseudo-code to set a random number to a variable var:

```
var = get a random number in the range 0—100
```

So to generate an addition question, and get the answer from the student, we can have the following pseudo-code:

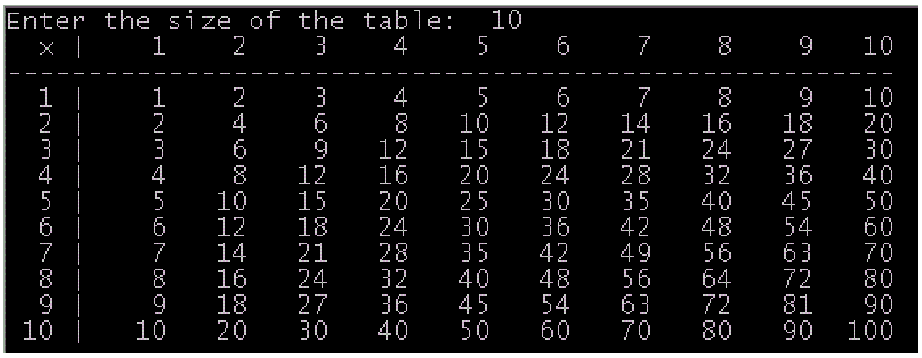
```
a = get a random number in the range 0—100
b = get a random number in the range 0—100
OUT "How much is the sum of a and b:  "
IN svar
```

Here, we use 2 variables a and b to keep 2 random values for the addition, while the answer is read into the variable named svar.

Please spend time to think how you could solve it. You need to consider the difference between selection and repetition structures to formulate your solution. When you are clear with the solution logic, you represent your solution in both pseudo-code and flowchart. You need to test it to see if it works correctly.

Grade 3-- Task 2 Multiplication Table

Develop an algorithm for printing a multiplication table. An example output is shown below, where the size of the table is 10 (input):



```
Enter the size of the table:  10
  x |    1    2    3    4    5    6    7    8    9   10
-------------------------------------------------------
  1 |    1    2    3    4    5    6    7    8    9   10
  2 |    2    4    6    8   10   12   14   16   18   20
  3 |    3    6    9   12   15   18   21   24   27   30
  4 |    4    8   12   16   20   24   28   32   36   40
  5 |    5   10   15   20   25   30   35   40   45   50
  6 |    6   12   18   24   30   36   42   48   54   60
  7 |    7   14   21   28   35   42   49   56   63   70
  8 |    8   16   24   32   40   48   56   64   72   80
  9 |    9   18   27   36   45   54   63   72   81   90
 10 |   10   20   30   40   50   60   70   80   90  100
```

Note: at the algorithm development, you do not need to consider how to produce the nicely formatted output. The formatted output will be realized later in lab, after the formatted output in C is discussed in Module 3 Basic C.

Consider the following questions when you develop the algorithm:

1) What is input, and what is the expected output. Develop test cases for the solution
2) Using top-down design approach, develop an algorithm to print a multiplication table with the input size.
3) Represent your algorithm in both pseudo-code and flowchart
4) Test your algorithm by going through the algorithm yourself with the test cases.

Grade 5-- Task 1 Computer Assisted Instruction (CAI)

The use of computers in education is referred to as computer assisted instruction (CAI). Write an algorithm that will help a primary school student practice subtractions (with numbers in the range 0—100). Your algorithm will generate a subtraction question and ask the student to give the answer. For example, your algorithm would print a question like

How much is 8 minus 6?   Answer =

The student then enters the answer. Your algorithm checks the student's answer. If it is correct, the algorithm prints "very good!" and the algorithm stops. If the answer is wrong, it prints "No. Please try again." And then let the student try the same question again repeatedly until the student finally gets it right. The algorithm will stop when the student has completed **10** subtraction questions correctly.

The key to this CAI algorithm is how to generate a question. We suppose that you can use the following pseudo-code to set a random number to a variable var:

```
var = get a random number in the range 0—100
```

So to generate an addition question, and get the answer from the student, we can have the following pseudo-code:

```
a = get a random number in the range 0—100
b = get a random number in the range 0—100
OUT "How much is the a - b:  "
IN svar
```

Here, we use 2 variables a and b to keep 2 random values for the addition, while the answer is read into the variable named svar.

Since the primary school student has not learnt the negative numbers, your subtraction question should not have a negative answer. For example, your algorithm should not generate a subtraction like "6 – 8".

Please spend time to think how you could solve it. You need to consider the difference between selection and repetition structures, and nested loops to formulate your solution. When you are clear with the solution logic, you represent your solution in both pseudo-code and flowchart. You need to test it to see if it works correctly.

Grade 5 task 2 has 2 options. You can choose one to solve:

Grade 5-- Task 2 (Option 1) Computation of e^x

This task requires knowledge on absolute value and factorial. You can read about factorial at https://en.wikipedia.org/wiki/Factorial.

The exponential function e^x can be represented by the Taylor series:

$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \ldots = \sum_{n=0}^{\infty} \frac{x^n}{n!},$$

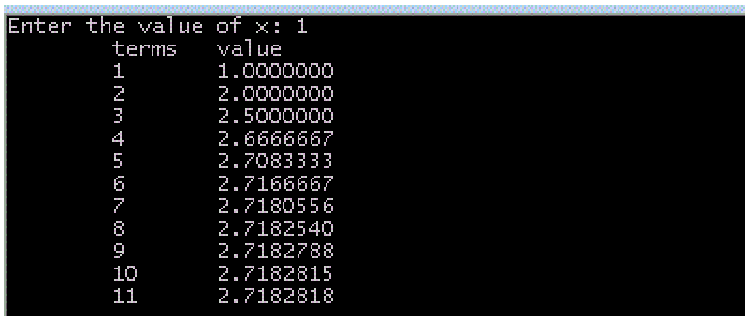
where n! denotes the factorial of n. This Taylor series is an infinite series and it is not possible for you to implement an infinite loop to compute the function. In practice, it is enough to add the first **n terms** as a good approximation. The more terms are summed, the result is more accurate.

The requirements on the solution are

a) You can only use basic addition, subtraction, multiplication, and division in your solution. No math function like pow( ) should be used in the computation.
b) The value of e^x is obtained by summing up terms in the Taylor series until it finds that the absolute value of a term is less than 0.0000001.
c) Your solution should print out a table of values summing up 1, 2, 3, …n terms. A sample output is given below.

Develop an algorithm to compute e^x:

1) What is input, and what is the expected output?
2) Develop the test cases, to be used to test your solution later
3) Using top-down design approach, develop an algorithm to compute e^x.
4) Represent your algorithm in both pseudo-code and flowchart



```
Enter the value of x: 1
             terms    value
             1        1.0000000
             2        2.0000000
             3        2.5000000
             4        2.6666667
             5        2.7083333
             6        2.7166667
             7        2.7180556
             8        2.7182540
             9        2.7182788
             10       2.7182815
             11       2.7182818
```

Grade 5-- Task 2 (Option 2) Pyramid

Develop an algorithm to print a pyramid in the following form (example size is 5). The size should be limited to be between 5 and 20. To print the pyramid, you can only use print a star and print a space:

```
    OUT " * "    and   OUT "  "
```

A sample pyramid of size 5:

```
    *
   **
  ***
 ****
*****
 ****
  ***
   **
    *
```

Consider the following questions, when you develop the algorithm:

1) What is the input? What is the expected output? Develop some test cases.
2) Using top-down design approach, develop an algorithm to print a pyramid of the form with desired size (5—20).
3) Represent your algorithm in both pseudo-code and flowchart