DT555B Programming in C

Lab 3 Calendar/ CAI

1. Introduction

Algorithm development is a fundamental aspect of programming and software engineering, and it plays a crucial role in solving complex problems. It's an acquired skill that's mastered through a lot of practice and requires a combination of creativity, analytical and critical thinking, as well as an understanding of data structures.

The primary objective of this lab is to get a deeper understanding in the application of the top-down design methodology, by applying it to a more complex problem. This approach involves systematically dissecting complex issues into manageable sub-problems and coming up with a step by step approach. The crux of effective problem-solving lies in the ability to deconstruct formidable challenges into smaller, more digestible tasks. By applying this approach, this lab aims to make us practice algorithmic thinking and problem solving skills.

Grade 3 Task Option 2-- A Simple CAI Program

The lab task involves creating a Computer-Assisted Instruction (CAI) program tailored for primary school students, focusing on numbers within the range of 0 to 100. The program is expected to offer a main menu where users can select between practicing, taking a test, or exiting the program.

For practice sessions, users can opt for additions only, subtractions only, or a mix of both. Each practice session comprises 10 questions where users provide answers. If an incorrect answer is given, the program persists in asking until a correct response is provided. After completing the practice, users are returned to the main menu.

In the test section, users can select additions only, subtractions only, or a mix of both for a test consisting of 15 questions. When an answer is given, the program continues to the next question. Upon completion, the program displays the test result as a percentage. Similar to the practice mode, users are directed back to the main menu after finishing the test, giving them the option to practice, take another test, or exit the program.

2. Design

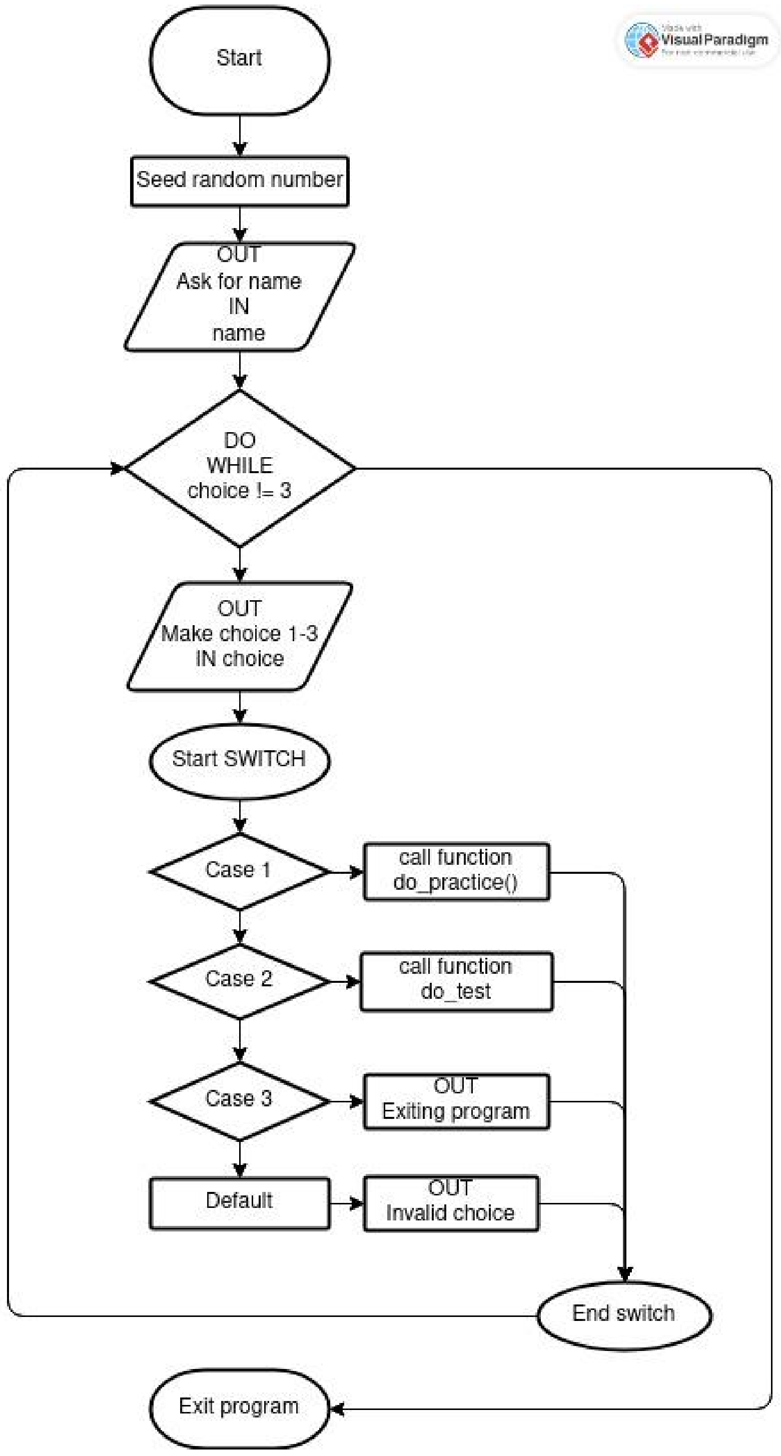
I started by looking at the problem and breaking it down into smaller tasks, to figure out the best way to solve it, within my skill level. I always use pen and paper at this stage. I then translated it into pseudocode and flowcharts before I implemented the code. I made separate flowcharts for each function, since it would have been harder to get an overview if all the steps of the functions were included in the main flowchart. The function I use to randomize numbers is just one line, so I did not feel the need to make a separate flowchart for it. In the pseudocode, I wrote it the way it would be written in the program, with the helper functions first and the main last.

The program starts by asking the user to enter their name, greets them welcome and then displays a menu with three available choices. If the user chooses alternative 1 or 2, they will be presented a new menu, where they can choose between addition, subtraction or a mix of both. It will then call one of two functions: do_practice() or do_test(). Alternative 3 will exit the program.

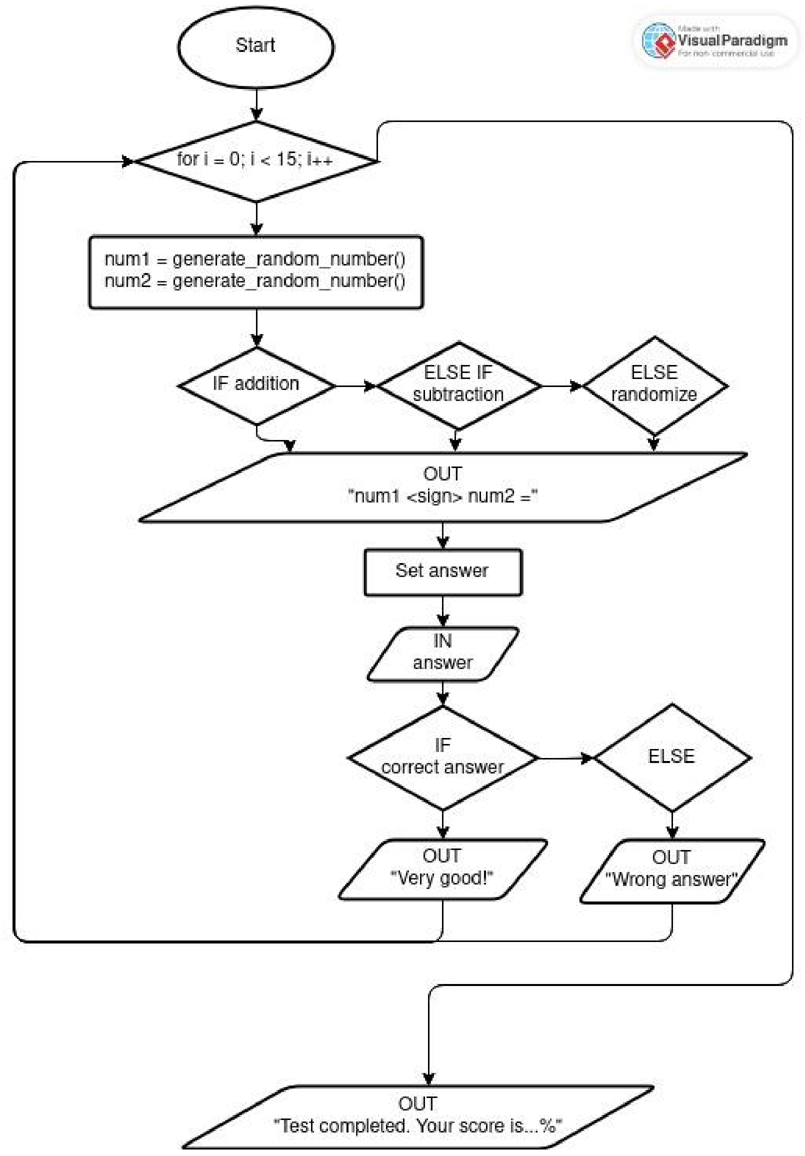
The functions for practice and test are very similar in design. Two numbers are randomly generated and depending on which calculation method the user chose, it will generate math questions. In the practice function, the user gets 10 questions and if the answer is incorrect, they will get the same question again until they get it right. In the test function, there's a number of 15 questions and the program will continue to the next question no matter if the answer is correct or not. At the end, a calculation of the result is being performed and the program outputs the percentage of correct answers.

Flowcharts

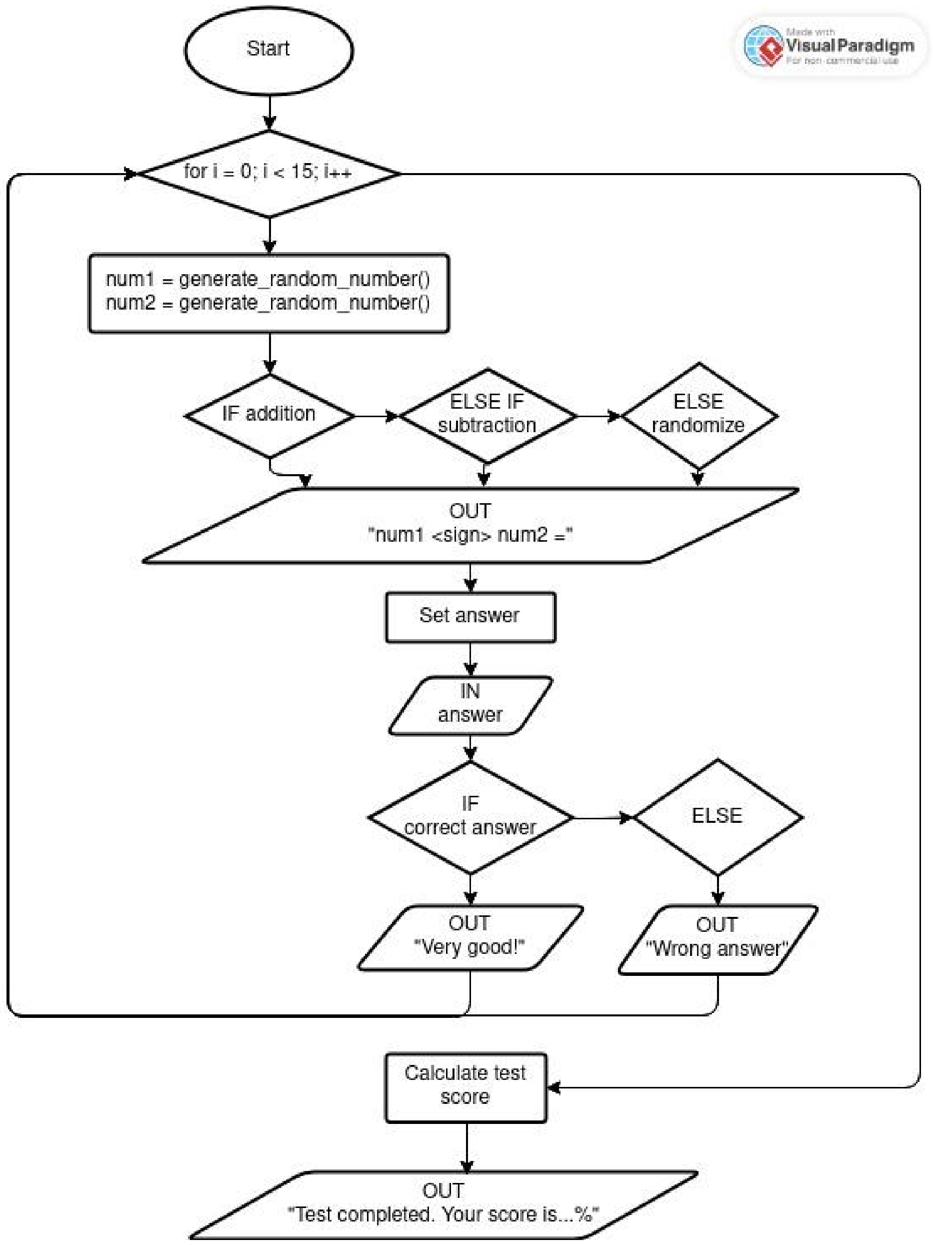
1. main()



2. do_practice



3. do_test



Pseudocode

```
**FUNCTION generate_random_number(min, max)**:
    Return a random number between min and max (inclusive)
```

```
FUNCTION do_practice(operation):
  correct = 0
  FOR i = 0; i < 10; i++
            num1 = generate_random_number(0, 100)
            num2 = generate_random_number(0, 100)
      IF operation is addition:
            OUT “num1 + num2 =”
            Set answer = num1 + num2
      ELSE IF operation is subtraction:
            OUT: num1 - num2 =
            Set answer = num1 - num2
       ELSE (mixed addition and subtraction):
            Randomly choose addition or subtraction
            OUT question
            Set answer based on chosen operation
      ENDIF
      IN user answer
      WHILE user answer != correct answer:
            OUT “No. Please try again. Enter your answer:”
      END WHILE
      OUT "Very good!"
      correct++;
END FOR
OUT “Practice completed. You got 10 out of 10 correct."

FUNCTION do_test(operation):
  correct = 0
  FOR i = 0; i < 15; i++;
            num1 = generate_random_number(0, 100)
            num2 = generate_random_number(0, 100)
            IF operation is addition:
                  OUT “num1 + num2 =”
                  Set answer = num1 + num2
            ELSE IF operation is subtraction:
                  OUT: num1 - num2 =
                  Set answer = num1 - num2
            ELSE (mixed addition and subtraction):
                  Randomly choose addition or subtraction
                  OUT question
                  Set answer based on chosen operation
            END IF
            IN user answer
            IF user answer == correct answer:
                OUT "Very good!"
                correct++;
            ELSE
                OUT "Wrong answer."
            END IF
        END FOR
        Calculate test score (correct * 100 / 15)
        OUT "Test completed. Your score is: percentage%"
```

FUNCTION main():

```
    Seed random number generator srand(time(NULL));
    Declare variables: name, choice, operation

    OUT "Enter your name: "
    IN user name
    OUT "Welcome, <name>"

    Repeat until user chooses to quit:
    DO
            OUT   "You can choose:
                1. Do practices
                2. Complete a test
                3. Quit the program
                Enter your choice: "
            IN user choice (1-3)
            SWITCH
                CASE 1:
                    OUT   "Now, you can choose to do practices on:
                        1. addition
                        2. subtraction
                        3. addition and subtraction
                        Enter your choice: "
                        IN user choice (1-3)
                        IF choice is invalid
                            OUT "Invalid choice."
                            BREAK
                        ENDIF
                        **do_practice(operation)**
                        BREAK
                CASE 2:
                    OUT "Now, you can choose to do a test on:
                        1. Additions
                        2. Subtractions
                        3. additions and subtractions
                        Enter your choice: "
                        IN user choice (1-3)
                        IF choice is invalid
                            OUT "Invalid choice."
                            BREAK
                        ENDIF
                        **do_test(operation)**
                        BREAK
                CASE 3:
                    OUT "Exiting the program. Goodbye, <name>"
                    BREAK
                DEFAULT
                    OUT "Invalid choice. Please enter a valid option."
    WHILE choice != 3
    END DO WHILE
    END PROGRAM
```

Test cases

Test all menu alternatives and go through all the options for both practice and test. Input both right and wrong answers and check that the program makes the correct calculations
and behave as expected.

3. Implementation and Test

The program starts with calling srand(time(NULL)); to ensure that the random number generator is seeded with different values each time the program is executed. I use scanf() for all user input and printf() for all output.

Since the program is repetitive and involves giving the user the same menu multiple times, I decided to use switch case in the main function, with 3 cases that correlates to the alternatives the user is given. I chose to place the switch case within a do-while loop since it executes at least once and for the menu to be shown, the loop will have to execute. The do-while keeps going until the user chooses alternative 3, which exits the program.

I made three separate functions with the following prototypes:

```
int     generate_random_number(int min, int max)
void    do_practice(int operation)
void    do_test(int operation)
```

generate_random_number

This function is used to generate randomized numbers for the math exercises. It's just one line and could easily have been done directly in the main, but this way the code gets more readable. It takes two parameters, int max and int min. In this program it's called with arguments min 0, max 100. Each time it's called, it returns a random number within that range.

do_practice

This function will have the user complete a practice session. It takes one argument, int operation. The function starts with declaring variables int i, num1, num2, answer, user_answer, correct. correct is initialized to 0 and will be used to count correct answers. If the entire practice session is completed, correct answers will always be 10 out of 10.

It then enters a for loop, which will execute 10 times. The code block inside the loop starts with calling generate_random_number() and assigning them to variables num1 and num2. Then it checks the value of the operation argument. If operation == 1, it will output "num1 + num2 = " and assign the correct answer to the answer variable. If operation == 2, the same thing happens, but with subtraction instead. If the user chose alternative 3, rand() is called to return a random number and if that number % 2 == 0, it will output a question with addition, else subtraction. Variable user_answer is assigned the value of the user input and is then checked against the variable answer. If user_answer != answer, it enters a while loop where the program asks the user to try again. The loop runs until user_answer == answer. It then outputs "Very good!", increment correct with 1 and restarts the loop. When the loop has run 10 times, the program outputs "Practice completed, you got 10 out of 10 correct answers". The program exits the function and returns to main().

do_test
This function works almost the same way as do_practice. The difference is that the for loop runs 15 times and there's no nested while loop, since it's not giving the user more than one try for each question. It will output "Very good!" if the answer is correct, else "Wrong answer." When the for loop has run 15 times, the program outputs "Test completed. Your score is <number>%". The calculation is being done directly in the function call: printf("Test completed. Your score is: %.2f%%\n", (float)(correct * 100) / 15). The program exits the function and returns to main().

After exiting the function, the user will again be presented with the menu and the do-while will run until the user chooses alternative 3, the program will then output "Exiting the program. Goodbye, <name>", exit the loop and end the program by returning 0.

4. Results and discussion

In this section, you present the result and discuss on the result.
You can include what problems you have encountered and how they are solved. You should also include reflection on what you have learnt in this section. In this way, you improve your understanding and skills in programming.

The program compiles and seems to behave as expected. The hardest part was to figure out how to make the program mix addition and subtraction, without hardcoding it to addition/subtraction every second question. That solution would have met the requirements, but I wanted to make a randomized solution and came up with using rand() to get a random number and use it for the selection, by checking if it's even (number % 2 == 0) or odd and it turned out well.

It was my first time using switch case, so I thought it was fun to see that it worked the way I was expecting.

Making the flowcharts was quite tricky. I can't get AlgoBuild to work, so I used VisualParadigm and it's buggy. When I inserted them here, I realized that I forgot to change the last else in do_practice was actually supposed to be a while and the output should show result without percentage. VisualParadigm failed to save my work, so changing it would mean I had to start over from the beginning, so I chose not to, since it's just a minor mistake.

Overall I think it was a fun project. Algorithms are of course essential in programming and learning to plan ahead before diving into the actual coding, really makes things easier later on.

5. References

The system manual for functions rand, srand, time, printf, scanf, using command line arguments:

"man rand"

"man srand"

"man time"

"man printf"

"man scanf"

I didn't use any other external references, besides the lectures provided on Canvas. I used VS Code to write and run the code and VisualParadigm for the flowcharts.