



## Computer Programming Language

【Fall, 2023】

### Computer Programming Problem Set for Hand-on Examination

1. Design a program to calculate the parking fee based on the parking time (in minutes) input by the user. The rate of parking fee is 20 NT dollars per 30 minutes. One minute to 30 minutes are considered as a 30-minute unit for 20 NT dollars. Parking time no more than 30 minute is free of charge. The maximum parking fee for a whole day is 240 NT dollars. The input of this program is the parking time in minutes from 1 to 2000 minutes. The output of the program is the parking fee. For example: parking time of 20 minutes is free; 30 minutes is free; 31 minutes is 40 NT dollars; 90 minutes is 60 NT dollars; 1440 minutes is 240 NT dollars; 1441 minutes is 260 NT dollars.

2. The following iterative sequence is defined for the set of positive integers:

$$n \rightarrow n/2 \text{ (if } n \text{ is even) or } 3n + 1 \text{ (if } n \text{ is odd)}$$

For example, using the rule above and starting with 13, we generate the following sequence:

$$13 \rightarrow 40 \rightarrow 20 \rightarrow 10 \rightarrow 5 \rightarrow 16 \rightarrow 8 \rightarrow 4 \rightarrow 2 \rightarrow 1$$

It can be seen that this sequence (starting at 13 and finishing at 1) contains 10 terms. Although it has not been proved yet (Collatz Problem), it is thought that all starting numbers finish at 1. Write a program to find the starting number, under 10,000, produces the longest chain.

3. Design a function that receives a string and processes the characters in that string into reverse order. For example: change string “HOW ARE YOU TODAY?” to “?YADOT UOY ERA WOH”. Use a main function to call this function and repeatedly ask user to input different strings until the user responses with a CTRL-Z key to exit the program.
4. Design a function with an input of  $M \times N$  matrix ( $M \leq 10, N \leq 10$ ) of distinct integer numbers and return all lucky numbers in the matrix in any order. A lucky number is an element of the matrix such that it is the minimum element in its row and maximum in its column. For example, 15 is a lucky number in the matrix  $\begin{bmatrix} 3 & 7 & 8 \\ 9 & 11 & 13 \\ 15 & 16 & 17 \end{bmatrix}$ . Use a main function to ask user to input the  $M \times N$  matrix, call this function, and output the result on the screen.
5. Design a function that estimates the value of  $e^x$  by using the following formula for  $n = 20$ . Use a main function to call this function and compute the values of  $e^1, e^2, e^3, e^4, \dots, e^{10}$ . Display your results on the computer screen.

$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \dots + \frac{x^n}{n!} + \dots$$

6. Design a function that calculates the greatest common divisor (GCD) and the least common multiple (LCM) of two positive integers. Use a main function to call this function. The main function needs to ask the user to input the two integers repeatedly until the user responses to end the program.



7. Design a program that computes the roots of a quadratic equations with one unknown:

$$ax^2 + bx + c = 0$$

The user inputs are the coefficients of the equation:  $a$ ,  $b$ , and  $c$ . The program needs to give the root or roots of the equation based on the value of  $b^2 - 4ac$ .

8. A pair of positive integer numbers are called twin primes if they are both prime numbers and the difference between them is 2, i.e., they are consecutive odd numbers and they are prime numbers. (3, 5), (5, 7) and (11, 13) are three examples of such pair of twin prime numbers. Write a program to display all the pairs of twin prime numbers that are less than 1000.
9. Design a function that can sort an array of integers. Also write a main program to call the function and sort the following integer array in ascending order. Display the integer array before and after sorting.

{3, 8, 10, 30, 2, 16, 27, 13, 22, 17, 42, 33, 38, 29, 14}

10. Write a program that simulates the rolling of two dice. Your program should roll the dice 100,000 times. Use a one-dimensional array to tally the numbers of times each possible value from 1 to 12, and display the results on the screen.
11. A narcissistic number is a positive integer which is equal to its digits sum raised to the number of digits in the integer. For example, the integer 153 is a narcissistic number because  $153 = 1^3 + 5^3 + 3^3$ . Write a program to find all the narcissistic numbers between 100 to 99999.
12. Design a function for matrix multiplication. The two input matrices are  $A (M \times L)$  and  $B (L \times N)$ , and the result is matrix  $C (M \times N, C = A \times B)$ . You need to use dynamic memory allocation approach (pointer) to solve this problem. Also write a main program to test your function.
13. Let  $d(n)$  be defined as the sum of proper divisors of  $n$  (numbers less than  $n$  which divide evenly into  $n$ ). If  $d(a) = b$  and  $d(b) = a$ , where  $a \neq b$ , then  $a$  and  $b$  are an amicable pair and each of  $a$  and  $b$  are called amicable numbers. For example, the proper divisors of 220 are 1, 2, 4, 5, 10, 11, 20, 22, 44, 55 and 110; therefore  $d(220) = 284$ . The proper divisors of 284 are 1, 2, 4, 71 and 142; so  $d(284) = 220$ . Write a program to find the sum of all the amicable numbers under 10000.

### Time and Venue of the Hand-on Examination:

**Time:** Nov. 30, 16:00~17:20

**Venue:** Room 116 of Computer and Information Networking Center, NTU