Computational Thinking and Problem Solving (COMP1002)

Assignment 1 Solutions

1. [15 marks] Convert the octal number, 10323646520, to hexadecimal number. Interpret the number in terms of ASCII code. What is the resulting text message? Show all your steps.

   $0 * 8^0 + 2 * 8^1 + 5 * 8^2 + 6 * 8^3 + 4 * 8^4 + 6 * 8^5 + 3 * 8^6 + 2 * 8^7 + 3 * 8^8 + 0 * 8^9 + 1 * 8^{10}$
   = 1129270608 [5 marks]

1129270608 / 16 = 70579413	**remainder = 0**
70579413 / 16 = 4411213	**remainder = 5**
4411213 / 16 = 275700	**remainder = 13 (D)**
275700 / 16 = 17231	**remainder = 4**
17231 / 16 = 1076	**remainder = 15 (F)**
1076 / 16 = 67	**remainder = 4**
67 / 16 = 4	**remainder = 3**
4 / 16 = 0	**remainder = 4**

   434F4D50 [5 marks]

   ASCII code conversion
   43 –> C, 4F –> O, 4D -> M, 50 -> P [5 marks]

2. [20 marks] Suppose you are given a *m* * *n* matrix, named, *M*, which represents a 2D greyscale image. Each value in the matrix presents a dot (or pixel) of the image. Assume the range of each value lies between 0 and 255 (i.e., [0, 255]). 0 represents black (no light) and 255 represents white (maximum light intensity level). The values lying between represent light intensity levels:
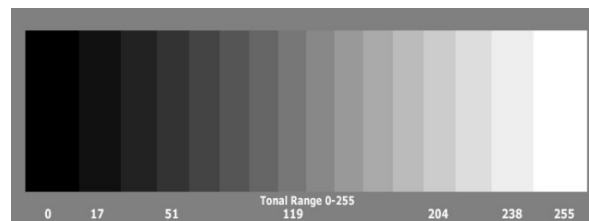

   Image source: https://www.baeldung.com/cs/convert-rgb-to-grayscale

   Given *M*, you are required to find out the intensity value that occurs most frequently. For example, if M =

   $$\begin{bmatrix} 22 & 23 & 125 \\ 125 & 137 & 23 \\ 23 & 158 & 200 \end{bmatrix}$$

   23 is the result. If there are more than two intensity values occurring most frequently, we only use the first found value.

   Write down the pseudocode to solve this problem. It should be detailed enough to illustrate the steps of traversing M, comparing and counting the pixels, in order to obtain the result. Also write down the *input* and *output* specifications.

   Input: The image matrix (M) [3 marks]
   Output: The intensity value that occurs most frequently (max) [3 marks]
   // Logic of traversing M [7 marks]
   Set L be a list of 256 integers.

For each x in L
    x = 0
For each row of M
    For each c in row
        Add 1 to L[c]

// Logic of finding the maximum [5 marks]
Set max = -1
For each y in L
    If y > max
        max = y

// Return the result [2 marks]
return max

3. [15 marks] In Lecture 2, the difference between function and procedure is mentioned. Suppose you are a software developer. You are given a document of technical specifications for developing a business application software package. Before your implementation of the software, you have to set up a software development tool (e.g., IDLE) to write programs. After months of development (with numerous cups of coffee intake), the software is created.

Do you act like a function or a procedure? What is/are the input(s) and output(s), if any? Justify your claim.

Input: A document of technical specifications [4 marks] (optional: coffee)
Output: A business application Software package [4 marks]

I act like a *function* with well-defined input and output. [3 marks]
Inside the function, I set up a software development tool (which is a change of the internal state) [4 marks]

4. [25 marks] Write a Python program that a user enters a valid positive integer in base 10. The program will display the corresponding octal number (base 8) in string data type. You are required to provide TWO test cases, which include the input and expected output, which is typed as *comments* at the beginning of your program. Your program should behave as below: [The input is 200 and the lines that follow are the outputs]

```
Please enter a decimal number(an integer number in base 10). >> 200
quotient 25
remainder 0
quotient 3
remainder 1
quotient 0
remainder 3

The octal number is: 310
```

```
1  def main():
2      num = int(input("Please enter a Decimal number(an integer number in base 10). >> "))
3      quotient = num
4      answer = ""
5      while num != 0:
6          quotient = num // 8
7          remainder = num % 8
8          print("quotient", quotient)
9          print("remainder",remainder)
10         answer = str(remainder) + answer
11         num = quotient
12     print("\nThe Octal number is:", answer)
13
14  main()
```

Input: 2 marks
Valid loop: 5 marks
Valid quotient function: 5 marks
Valid quotient: 5 marks
Correct answer: 5 marks
TWO test cases written as comments: 3 marks

5. [25 marks] Write a Python program to calculate the root(s) of the quadratic equation, $ax^2 + bx + c = 0$. The program flow is shown as below:

    a. A user is asked to provide a, b, c values;
    b. The program will calculate and check the discriminant value;
    c. Based on b., the program, will calculate and print the number of root(s) and root value(s).

You may assume the user always input decimal values and no input validation is required.

(Hints: You may refer to https://en.wikipedia.org/wiki/Quadratic_equation or other sources for more information about quadratic equation.)

Your program should behave like below:

Case 1
```
The programme is to calculate the root(s) of the quadratic equation, ax^2+bx+c=0.
Please enter the value a. >> 3
Please enter the value b. >> 4
Please enter the value c. >> 5
Invalid input.
```

Case 2
```
The programme is to calculate the root(s) of the quadratic equation, ax^2+bx+c=0.
Please enter the value a. >> 2
Please enter the value b. >> 4
Please enter the value c. >> 2
There is only one root: -1.0
```

Case 3

```
The programme is to calculate the root(s) of the quadratic equation, ax^2+bx+c=0.
Please enter the value a. >> 1
Please enter the value b. >> -3
Please enter the value c. >> -4
There are two roots:(4.0,-1.0)
```

```python
1  def main():
2      print("The programme is to calculate the root(s) of the quadratic equation, ax^2+bx+c=0.")
3      a = eval(input("Please enter the value a. >> "))
4      b = eval(input("Please enter the value b. >> "))
5      c = eval(input("Please enter the value c. >> "))
6      # discriminant
7      D = b**2 - 4*a*c
8      if(D < 0):
9          print("Invalid input.")
10     elif(D == 0):
11         r = (-b) / (2*a)
12         print("There is only one root: ",r, sep='')
13     else:
14         r1 = (-b + D**(0.5)) / (2*a)
15         r2 = (-b - D**(0.5)) / (2*a)
16         print("There are two roots:(", r1,",", r2,")", sep='')
17
18 main()
```

Input: 3 marks
Discriminant formula: 4 marks
Correct if-elif-else: 5 marks
Correct formulas for roots: 8 marks
Correct output message: 5 marks