CO 206: Design and Analysis of Algorithms Autumn 2019

Programming Assignment 4

Arindam Karmakar

1 Write C/C++/Python code for the following problems:

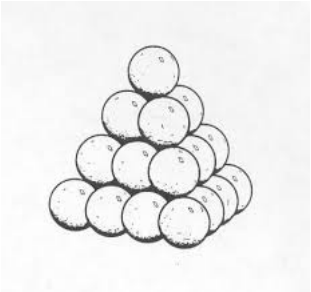
a) Consider a set $A = a_1, a_2, \ldots, a_{n-1}, a_n$ of n items where each a_i is a positive integer and a value Z as input for the following problem:

Is there a subset $A' = \{a_{i_1}, a_{i_2}, \ldots, a_{i_k}\} \subseteq A$ **such that**
$\mathbf{Z} = \square\mathbf{a_{i_1}}\square\ \mathbf{a_{i_2}}\square \ldots \square\ \mathbf{a_{i_k}}$ where $\square$ is $+$ or $-$?.

For example, if the given input is $\{3, 5, 4\}$ and $Z = 2$ we can have $2 = -3+5$. while we do not have any combination for $Z = 10$. For $Z = 6$ we have the combination $6 = -3+5+4$.

Write a recursive function IsSummable(Z, A) that determines whether it is possible to find a subset $A' \subseteq A$ such that the value Z can be realized by a combination of the elements A' using only two operations $+$ or $-$.

b) You are viewing a pyramid-shaped structure of balls with one ball at the top which is on top of a square of four balls which are also sitting on top of a square of nine balls, and so on. You want to count the number of balls in the pyramid. You don't have time to count the balls one by one. What you can count is the number of levels in the pyramid. Write a recursive function CountBall( ) that takes the height of the pyramid as input and returns the number of balls.



c) You have joined a new club with many new friends; some of them are HONEST and the rest are DISHONEST. You don't know who are HONEST/DISHONEST. Obviously you want to make HONEST ones your friends. But there is authentic source to get the information. What you can do is to ask A to comment about another friend B and vice-versa. HONEST people always correctly determine if their partner is HONEST or DISHONEST. A DISHONEST person may or may not give a correct answer when asked about another. Thus if you ask A about another friend B and vice-versa there are four possible outcomes and associated conclusions.

Friend A says	**Fiend B says**	**Conclusion**
B is HONEST	A is HONEST	Both are HONEST or Both are DISHONEST
B is HONEST	A is DISHONEST	At least one of them is DISHONEST
B is DISHONEST	A is HONEST	At least one of them is DISHONEST
B is DISHONEST	A is DISHONEST	At least one of them is DISHONEST.

Following are the additional information you can assume to be TRUE:

a) Dishonest person does not change his/her comments about another if asked twice.

b) More than half of the persons in the club are HONEST.

Design a divide and conquer algorithm for the above problem. Your solution should work in two stages

1. Find one HONEST friend.
2. With the help of this HONEST friend identify all the HONEST friends.

Each person can be identified by a single integer, with 1 representing HONEST and 0 representing DISHONEST. We can't directly look at a person's identity, we have to ask another person to comment for us (as explained above). If the person that is identifying is HONEST (i.e. its value is 1) then it will tell us the TRUTH about the person being checked. But if the person himself is DISHONEST (i.e. its value is 0) then it may or may not tell us the truth about the other person.