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## CS29003 Algorithms Laboratory

### Assignment 2: Recursive Formulation for Algorithm Design

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#### General instruction to be followed strictly

1. Do not use any global variable unless you are explicitly instructed so.
2. Do not use Standard Template Library (STL) of C++.
3. Use proper indentation in your code and comment.
4. **Name your file as `<roll_no>_<assignment_no>`. For example, if your roll number is 14CS10001 and you are submitting assignment 3, then name your file as `14CS10001_3.c` or `14CS10001_3.cpp` as applicable.**
5. **Write your name, roll number, and assignment number at the beginning of your program.**
6. Make your program as efficient as possible. Follow best practices of programming.
7. Submit your program on Moodle before deadline. Submissions by email or any other means will NOT be considered for evaluation.

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Suppose Ramu has  $n$  apples to sell in a market. There are  $m$  people in the market who have come to buy apples. Obviously every buyer in the market will distribute the apples among his/her family members. However, to ensure equal distribution of apples, the number of apples that a buyer is ready to buy should be a multiple of his/her family size (including himself/herself of course and thus family size is always at least 1). For example, if the size of the family of a buyer is 10 then, the buyer is ready to buy  $10k$  apples for every integer  $k \geq 1$ . Each buyer of course has a price per apple which he/she is ready to pay; this price does not depend on the quantity of apples that he/she buys. For example, suppose a buyer is ready to pay 15 rupees per apple and his/her family size is 2, then the possible buying options for him/her is 0 apples for 0 rupees, 2 apples for 30 rupees, 4 apples for 60 rupees, etc. Ramu of course wants to maximize his earning. For example, suppose Ramu has 9 apples to sell. There are 3 buyers with family sizes 4, 3, 1 and price per apple 12, 10, 2 respectively. Then Ramu should sell 8 apples to the first buyer, 0 apples to the second buyer, and 1 apple to the third buyer to maximize his earning which is 98 rupees. Observe that an earning maximizing selling strategy may fail to sell all the apples which is okay.

In this assignment, you design an algorithm for telling Ramu how many apples to sell to each buyer to maximize his earning.

### Part I: Recursion

Use recursive problem formulation taught in the class to design an algorithm for this problem. Write a recursive function to implement it.

### Part II: Dynamic Programming

Implement the recursive definition designed in part I using dynamic programming. Increase the input size to see the difference in time complexity of the two algorithms in part I and II.

Submit a single .c or .cpp file. Your code should get compiled properly by gcc or g++ compiler.

## Sample Output

```
palash@palash-ThinkPad-X1-Yoga-3rd:~$ ./a.out
Write the number of apples that Ramu has: 1000
Write the number of buyers: 5
Write family sizes:
7 11 13 17 19
Write prices:
32 31 34 33 35
Output of recursive implementation
Maximum earning is 34924. Selling pattern is
14, 0, 0, 17, 969,
Output of dynamic programming implementation
Maximum earning is 34924. Selling pattern is
14, 0, 0, 17, 969,
palash@palash-ThinkPad-X1-Yoga-3rd:~$
```

## Policy on Plagiarism

**Academic integrity is expected from all the students. Ideally, you should work on the assignment/exam consulting only the material we share with you. You are required to properly mention/cite anything else you look at. Any student submitting plagiarised code will be penalised heavily. Repeated violators of our policy will be deregistered from the course. Read [this](#) to know what is plagiarism.**