# ESC101 : Fundamental of computing

**Exercises on recursion** **31 October, 2008**

**Note :** If you are able to solve at least two problems out of the following problems on your own, you should feel confident about the topic recursion.

1. Generate all strings of length $n$ consisting of 0s and 1s without any two consecutive 1s.
2. There is a $n \times n$ grid. You start from bottom left corner and you have to go to top right corner. At each stage you may move either one step up or one step right. Design a program to enumerate all paths to reach top right corner. You may use string "up" and "right" to express the move done in one step.
3. **Combination with repetition allowed** Generate all combinations of length L using characters from set A, with repetition allowed. For example, for A=$\{a, b, c\}$ and $L = 2$, the corresponding combinations are

   ```
   aa
   ab
   bc
   bb
   ac
   cc
   ```

4. **Partitions of a positive integer**
   (a) Given a positive integer n, print all permutations of positive integers such that
      1. their sum is n
      2. the value of the numbers in the permutation is non-decreasing

   (b) Solve the above problem but with the change that the value of the numbers in the permutations are strictly increasing

   (c) For a positive integer $n$, generate all permutations of 1s and 2s which sum upto n.

   (d) Given a positive integer $n$, print all those sets of positive integers whose sum is n.
5. We know that an expression involving parenthesis is valid if for each right parenthesis there is a unique left parenthesis to match. Generate all valid expressions consisting of $n$ left parenthesis and $n$ right parenthesis. For example, for $n = 3$, there are five valid expressions :

   ```
   {}{}{}
   {{}}{}
   {}{{}}
   {{{}}}
   {{}{}}
   ```

   Thanks to Sthitadhi Roy AND K. Venkata for pointing out a mistake in earlier version where I forgot to mention the last expression {{}{}} as a valid expression.
6. **Permutations of a string with repeated characters** Given a string of length $n$ with possibly repeated characters, print all permutations of length $L$. For example, if string is abac, and $L = 2$ then the set to be enumerated has following strings :

   ```
   aa
   ab
   ac
   ba
   bc
   ca
   cb
   ```

   (this one has relatively longer solution and code.)