

SML and Python: Lists

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1. As a start, type "open List" on the console to see all functions of List structure. Find out what the functions null,hd,tl,nth,take,drop,length do.
2. (a) Write SML code to reverse a list. Initially it is given that the user will enter a list of integers only
 - i. Prove your code is correct
 - ii. Give the time complexity of your code. Is it the most efficient algorithm?
 - iii. Write down cases for which your code gives an error. How do you handle such cases? Do you throw exceptions or do you make sure the input follows certain rule?
- (b) Now you are given that the user might enter any type of list.
 - i. Do you need to change your code to make it work for a general list?
 - ii. Does your code works if the given list is
 - A. list of characters
 - B. list of strings
 - C. list of lists
 - D. list of list of lists
3. Write a program which takes in a pair of positive integers x and y , ($0 < y \leq x < 25$), and outputs all the possible permutations of choosing y integers from the set $\{1, 2, \dots, x\}$. The input is just one line with two integers separated by a white space. The output should print one

permutation per line, and final line containing the number of permutations printed. The permutations should be printed in ascending order lexicographically (e.g. 1 2 precedes 1 3).

4. Write a recursive Python program which inputs a list L from the user and reverses the order of elements in the input list L. What is the time complexity of your program ?
5. Consider a list of strings which stores the names of people. Write a program to check whether a given input name matches any of the names present in the list. Note that here, we are not only looking for exact matches, but also substring matches i.e. whether the input name is a substring (or exact match) of any of the names in the list. For example, if the input name is 'Rahul' and your list has an element 'Rahul Dravid' then you should declare it a match. Write a Python program which inputs a list of names and a name to be matched from the user and achieves the above functionality.
6. Matrices can be implemented in SML using list of lists. As done for sets, implement the following functions:
 - (a) Addition(Matrix X1, Matrix X2) : Returns the matrix formed by addition of M1 and M2.
 - (b) Multiplication(Matrix X1, Matrix X2) : Returns the matrix formed by $M1 * M2$.
 - (c) Rank(Matrix M1): Given a matrix M1, returns its rank
 - (d) Determinant(Matrix M1): Given a square matrix, returns the value of the corresponding determinant.

Now answer the following questions.

- (a) Find the time complexity of each of the functions above. Are these the most efficient algorithms?
- (b) The input given by the user may not always be correct. It may not be a proper list of list, or the dimensions might be incorrect for the operations. How do you handle such cases?
- (c) Can an empty list be considered as a valid matrix representation? Why/Why not?
- (d) If instead of list you had arrays (with GetElement and PutElement as $O(1)$ operations) as in Python, would they have helped in increasing efficiency of the operations above? Why/Why not?