

## Assignment 2 — 2014

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**Q0 [10]**

(a) [5] Design the signature pre and post-conditions for a procedure that computes the set of all  $n$  letter words that can be made from the items of the set where  $n$  is a natural number.

(b) [5] Design the procedure.

**Q1 [10]** Given a sequence of one or more arrays that we wish to find the product of, say  $ABCDE$ , there are several ways the sequence could be parenthesized. In the example we have

$$\begin{aligned} &(A(B(C(DE)))) \\ &(A(B((CD)E))) \\ &((AB)(C(DE))) \\ &((AB)((CD)E)) \\ &(((AB)C)(DE)) \\ &((((AB)C)D)E) \end{aligned}$$

(a)[5] Design a procedure that, given a sequence of  $n$  characters, prints a list that contains of all parenthesizations of that sequence. Include pre- and postconditions, even if they are not very formal.

(b)[5] Suppose that besides a sequence of  $n$  characters (representing the names of matrices), we are also given a list  $D$  of  $n+1$  dimensions. The dimensions of matrix  $i$  are  $D(i)$  rows by  $D(i+1)$  columns. Each parenthesization is then associated with a cost which is the sum of the costs of the multiplications. The cost of multiplying a  $p$  by  $q$  matrix with a  $q$  by  $r$  matrix is  $p \times q \times r$ .

Design an algorithm to compute the cost of the least-cost parenthesization. Do not worry too much about efficiency of your algorithm.

**Q2 [5]** An ordered tree is a directed tree such that each node is either a leaf or a branch. Leaves have no children. Branches have a sequence of 0 or more children. For this question, nodes are labelled with nonempty, finite strings consisting of lower-case letters.

Design a context-free grammar that describes the language of depth-first traversals of such finite ordered trees. Three examples from the language are

```
fred
georgina()
henry(ingrid(john),kate,marty())
```

In these examples **fred**, **john**, and **kate** label leaf nodes; **georgina** and **marty** label branch nodes with no children; **ingrid** labels a branch node with one child; and **henry** labels a branch node with three children.

Be sure to describe the alphabet, the nonterminal set, the starting nonterminal, and the production set of the grammar.

**Bonus [5]** Design a procedure that inspects a string and determines whether it is in the language described in Q2.