Addis Ababa University, Amist Kilo July 13, 2011

Algorithms and Programming for High Schoolers

Lab 8

Exercise 1: Write a recursive procedure `addDigits`(n) which takes a nonnegative integer n and returns the sum of the digits of n.

Exercise 2: Python already has a function `reverse()` for lists (`L.reverse()` reverses the `list` L). Let's implement our own `reverse()` function using recursion. `reverse`(L) should be a recursive function that outputs a `list` which contains the elements of L in reverse. Remember that L[i:] evaluates to a `list` containing only the elements of L from index i onward.

Exercise 3: Write a recursive procedure `minElement`(L) which takes a `list` L of integers and returns the minimum element in the `list`.

Exercise 4: A *superknight* is on a chessboard, at grid location $(0, 0)$ (the bottom left corner). How many ways can he get to the location (x, y) if his allowed moves are given in the `list` L? Write a function `numKnightWays`(x,y,L) that returns this number. Each element in L is a list of size two [i,j] signifying that it is possible for the knight to move from (a, b) to $(a + i, b + j)$. i, j are always both positive.

Exercise 5: An *expression* is defined recursively as follows. An integer is an expression, which evaluates to the integer itself. If `EXPR` is an expression, then so is (`EXPR`), and it evaluates to whatever `EXPR` evaluated to. Finally, if `EXPR1` and `EXPR2` are expressions, then (`OP EXPR1 EXPR2`) is an expression, where `OP` can be any one of $+, -, *$, and it evaluates to `evaluate`(`EXPR1`) `OP` `evaluate`(`EXPR2`). You should write a function `evaluate` which takes a `str` and evaluates the expression it is a valid expression, and outputs "INVALID" if it is not a valid expression. For example:

- `evaluate`('(+ 1 5)') gives 6.
- `evaluate`('(* 3 (- 5 2))') gives 9 (first (- 5 2) is evaluated as $5 - 2 = 3$, and then we have $3 * 3 = 9$).
- `evaluate`('(+ 1 (+ 5))') gives "INVALID" since (+ 5) is not a valid expression.
- `evaluate`('()') gives "INVALID" since the empty string is not a valid expression.