Assignment 3

Out: Tuesday, 26 September 2006
Due: Thursday, 05 October 2006

Total: 120 points

Exercise 1 (20 points) Please implement a function that takes a list and returns all the permutations of the list. The name and the type of the function is given below:

val list_permute : 'a list -> ('a list) list

Exercise 2 (50 points) Please implement a rational number structure Rational according to the following signature.

signature RATIONAL =
  sig
    type t (* for rationals *)
    exception DenominatorIsZero
    val zero: t
    val one: t
    val rat: int * int -> t
    val fromInt: int -> t
    val numerator: t -> int
    val denominator: t -> int
    val make: t -> int * int
    val isZero: t -> bool
    val isNegative: t -> bool
    val isPositive: t -> bool
    val eq: t * t -> bool
    val neg: t -> t
    val add: t * t -> t
    val sub: t * t -> t
    val mul: t * t -> t
  end
exception DivisionByZero
val recip : t -> t
val div : t * t -> t
val toString : t -> string
end

Exercise 3 (50 points) Let us generalize the problem of game-of-24 as follows. Fix a rational ans. Given n rationals \( r_1, \ldots, r_n \), we say that \( (r_1, \ldots, r_n) \) is a good ans-group if

1. \( n = 1 \) and \( r_1 = \text{ans} \), or

2. there exist \( i \) and \( j \) such that \( 1 \leq i < j \leq n \) and \( (r, r_1, \ldots, r_{i-1}, r_{i+1}, \ldots, r_{j-1}, r_{j+1}, \ldots, r_n) \) is a good ans-group for some rational \( r \) equal to \( r_i + r_j, r_i - r_j, r_j - r_i, r_i \cdot r_j^\prime, r_i / r_j \) (if \( r_j \neq 0 \)), or \( r_j / r_i \) (if \( r_i \neq 0 \)).

Please implement a function in SML that takes ans and a nonempty list of rationals and returns true or false depending on whether this list of rationals is a good ans-group or not. The name and the type of the function is given below:

val play : Rational.t * Rational.t list -> bool

where Rational is the structure mentioned in the previous exercise.