BU CAS CS 320 (Fall Semester, 2006)
Concepts of Programming Languages

Assignment 3

Out: Tueday, 26 September 2006
Due: Thursday, 05 Octorber 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
```

```
    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* $r_1 =$ 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* $r_i + r_j$,$r_i - r_j$,$r_j - r_i$,$r_i * r_j$,r_i/r_j *(if* $r_j \neq 0$*), or* r_j/r_i *(if* $r_i \neq 0$*).*

Please implment 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.