CSE 341, Spring 2014, Assignment 1
Due: Wednesday April 9, 11:00PM

You will write 11 SML functions (and tests for them) related to calendar dates. In all problems, a "date" is an SML value of type `int*int*int`, where the first part is the year, the second part is the month, and the third part is the day. A "reasonable" date has a positive year, a month between 1 and 12, and a day no greater than 31 (or less depending on the month). Your solutions need to work correctly only for reasonable dates, but do not check for reasonable dates (that is a challenge problem) and many of your functions will naturally work correctly for some/all non-reasonable dates. A "day of year" is a number from 1 to 365 where, for example, 33 represents February 2. (We ignore leap years except in one challenge problem.)

1. Write a function `is_older` that takes two dates and evaluates to true or false. It evaluates to true if the first argument is a date that comes before the second argument. (If the two dates are the same, the result is false.)

2. Write a function `number_in_month` that takes a list of dates and a month (i.e., an `int`) and returns how many dates in the list are in the given month.

3. Write a function `number_in_months` that takes a list of dates and a list of months (i.e., an `int list`) and returns the number of dates in the list of dates that are in any of the months in the list of months. *Assume the list of months has no number repeated.* Hint: Use your answer to the previous problem.

4. Write a function `dates_in_month` that takes a list of dates and a month (i.e., an `int`) and returns a list holding the dates from the argument list of dates that are in the month. The returned list should contain dates in the order they were originally given.

5. Write a function `dates_in_months` that takes a list of dates and a list of months (i.e., an `int list`) and returns a list holding the dates from the argument list of dates that are in any of the months in the list of months. *Assume the list of months has no number repeated.* Hint: Use your answer to the previous problem and SML's list-append operator (`@`).

6. Write a function `get_nth` that takes a list of strings and an `int` n and returns the n^{th} element of the list where the head of the list is 1^{st}. Do not worry about the case where the list has too few elements: your function may apply `hd` or `tl` to the empty list in this case, which is okay.

7. Write a function `date_to_string` that takes a date and returns a `string` of the form `January 20, 2014` (for example). Use the operator `^` for concatenating strings and the library function `Int.toString` for converting an `int` to a `string`. For producing the month part, do *not* use a bunch of conditionals. Instead, use a list holding 12 strings and your answer to the previous problem. For consistency, put a comma following the day and use capitalized English month names: January, February, March, April, May, June, July, August, September, October, November, December.

8. Write a function `number_before_reaching_sum` that takes an `int` called *sum*, which you can assume is positive, and an `int list`, which you can assume contains all positive numbers, and returns an `int`. You should return an int n such that the first n elements of the list add to less than sum, but the first $n+1$ elements of the list add to *sum* or more. Assume the entire list sums to more than the passed in value; it is okay for an exception to occur if this is not the case.

9. Write a function `what_month` that takes a day of year (i.e., an `int` between 1 and 365) and returns what month that day is in (1 for January, 2 for February, etc.). Use a list holding 12 integers and your answer to the previous problem.

10. Write a function `month_range` that takes two days of the year `day1` and `day2` and returns an `int list [m1,m2,...,mn]` where `m1` is the month of `day1`, `m2` is the month of `day1+1`, ..., and `mn` is the month of day `day2`. Note the result will have length `day2 - day1 + 1` or length 0 if `day1>day2`.

11. Write a function `oldest` that takes a list of dates and evaluates to an `(int*int*int) option`. It evaluates to `NONE` if the list has no dates and `SOME` d if the date d is the oldest date in the list.

12. **Challenge Problem:** Write functions `number_in_months_challenge` and `dates_in_months_challenge` that are like your solutions to problems 3 and 5 except having a month in the second argument multiple times has no more effect than having it once. (Hint: Remove duplicates, then use previous work.)

13. **Challenge Problem:** Write a function `reasonable_date` that takes a date and determines if it describes a real date in the common era. A "real date" has a positive year (year 0 did not exist), a month between 1 and 12, and a day appropriate for the month. Solutions should properly handle leap years. Leap years are years that are either divisible by 400 or divisible by 4 but not divisible by 100. (Do not worry about days possibly lost in the conversion to the Gregorian calendar in the Late 1500s.)

Note: Remember the course policy on challenge problems.

Note: The sample solution contains *roughly* 75–80 lines of code, not including challenge problems.

Summary

Evaluating a correct homework solution should generate these bindings:

```
val is_older = fn : (int * int * int) * (int * int * int) -> bool
val number_in_month = fn : (int * int * int) list * int -> int
val number_in_months = fn : (int * int * int) list * int list -> int
val dates_in_month = fn : (int * int * int) list * int -> (int * int * int) list
val dates_in_months = fn : (int * int * int) list * int list -> (int * int * int) list
val get_nth = fn : string list * int -> string
val date_to_string = fn : int * int * int -> string
val number_before_reaching_sum = fn : int * int list -> int
val what_month = fn : int -> int
val month_range = fn : int * int -> int list
val oldest = fn : (int * int * int) list -> (int * int * int) option
```

Of course, generating these bindings does not guarantee that your solutions are correct. *Test your functions: Put your testing code in a separate file. We will not grade the testing file, but you must turn it in.*

Assessment

Solutions should be:

- Correct
- In good style, including indentation and line breaks
- Written using features discussed in class. In particular, you must *not* use SML's mutable references or arrays. (Why would you?) Also do *not* use pattern-matching; it is the focus of the next assignment.

Turn-in Instructions

- Put all your solutions in one file, `hw1.sml`. Put tests you wrote in `hw1_test.sml`.
- Follow the dropbox link on the course website (homework section), follow the "Homework 1" link, and upload your files.
- If you have trouble using the dropbox, contact the course staff *before* the deadline.

Syntax Hints

Small syntax errors can lead to strange error messages. Here are 3 examples for function definitions:

1. `int * int * int list` means `int * int * (int list)`, not `(int * int * int) list`.
2. `fun f x : t` means the *result type* of `f` is `t`, whereas `fun f (x:t)` means the *argument type* of `f` is `t`. There is no need to write result types (and in later assignments, no need to write argument types).
3. `fun (x t)`, `fun (t x)`, or `fun (t : x)` are all wrong, but the error message suggests you are trying to do something much more advanced than you actually are (which is trying to write `fun (x : t)`).