CS 2SC3 and SE 2S03

McMaster University, Fall 2009

Assignment 4

Instructor: William M. Farmer

Revised: 4 November 2009

Files due: 13 November 2009

1   Overview

The purpose of this programming assignment is to create a mutable data structure for storing vectors using linked lists and multiple code files.

2   Background

For the purposes of this assignment, let us define a *vector store* to be a data structure that holds a finite sequence of vectors ordered by magnitude from smallest to largest. A vector store can be represented by a linked list of vectors and an integer called the *size* of the store.

3   Requirements

3.1   File requirements

This assignment requires three files: `prog4.ml`, `test4.ml`, and `log4.txt`. The `prog4.ml` file holds an implementation of a vector store as a linked list; it defines a module named `Prog4`. The `test4.ml` file holds testing code for the vector store implementation; it defines a module named `Test4`. The testing code in `test4.ml` calls the components of the module `Prog4`. And the `log4.txt` files holds a copy of your log book.

3.2   Implementation Requirements

Write an implementation of a vector store that includes the following components. Put the implementation code in `prog4.ml`.

1. A definition of a type `vector` as a type of records with two immutable fields `x` and `y` of type `float` such that the pair (x, y) represents a vector in 2-dimensional Euclidean space.

2. A function named `vec_mag` of type

```
vector -> float
```

that maps a vector to its magnitude.

3. A vector store data structure defined by the following:

   (a) A type `node` defined as a sum type consisting of a null node and tagged records having an immutable field of type `vector` and a mutable field of type `node`.

   (b) A type `vec_store` defined as a type of records with mutable fields `seq` of type `node` and `size` of type `int`. The `seq` field holds either the null node (if the size of vector store is 0) or the first node of a linked list of nodes.

   (c) An exception `Out_of_bounds`.

   (d) A constructor `make_vec_store` of type

```
unit -> vec_store
```

   that constructs a vector store whose size is 0.

   (e) A selector named `get_vec` of type

```
vec_store -> int -> vector
```

   such that `get_vec` s i gets the ith vector in s. If i is negative or greater than s.`size` $- 1$, the `Out_of_bounds` exception is raised.

   (f) A mutator named `delete_vec` of type

```
vec_store -> int -> unit
```

   such that `delete_vec` s i deletes the ith vector in s (and thus decrements the size of s). If i is negative or greater than s.`size` $-$ 1, the `Out_of_bounds` exception is raised.

   (g) A mutator named `insert_vec` of type

```
vec_store -> vector -> unit
```

   such that `insert_vec` s v inserts vector v into s (and thus increments the size of s).

   (h) The vectors in s are stored as a linked list of vectors ordered by magnitude from smallest to largest. (The order is preserved by the mutators.)

3.3 Testing Requirements

Write code that tests the vector store implementation and that satisfies the following requirements. Put the testing code in `test4.ml`.

1. The implementation of the vector store is tested by making a representative series of calls to the constructor, selector, and mutators.

2. The results of these test calls are printed out when the program is executed.

3. The testing code catches the `Out_of_bounds` exception.

3.4 Submission Requirements

Create a directory named `assign4`. Put the files `prog4.ml`, `test4.ml`, and `log4.txt` into this directory. Using subversion, import this directory into your directory in the course subversion repository at

    https://websvn.mcmaster.ca/se2s03

Your files must be submitted no later than **10:30 a.m. on Friday, November 13, 2009.**

4 Marking Scheme

This assignment is worth 100 points allocated as follows:

1. **Objective** (checked automatically by software)

    (a) Program files are present   _____/10 pts.
    (b) Program compiles   _____/10 pts.
    (c) Program runs   _____/10 pts.
    (d) Program prints test results   _____/10 pts.
    (e) Program passes objective tests   _____/20 pts.

2. **Subjective** (assessed by TAs)

    (a) Program satisfies the requirements   _____/20 pts.
    (b) Choice of test inputs   _____/10 pts.
    (c) Quality of print out of test results   _____/10 pts.
    (d) Style (comments only)

3. **Penalties**

    (a) Missing or substandard log book   _____/-10 pts.

Notes:

1. A program that is submitted late will receive 0 points.

2. Your program must compile and execute correctly on mills to receive full marks.

3. Your program must be your own work.

5   Extra Challenge

1. Do the assignment over with a vector store defined as a data structure that holds a queue of vectors.