Review Questions

July 15, 2015

1. Suppose you create a 2-D array, `int myArray[5][4]`, and then fill it up. Can you access an element using `myArray[0][8]`? If yes, which element will it access? If not, why not?

2. Suppose you have an "int" array declared as: `int myArray[20]`. The first byte in the array has the address 1010. What are the addresses of the first and last bytes of `myArray[13]`? The size of `int` is 4 bytes. (4 points)

3. Suppose you are given two integer matrices A and B, both of size N rows by M columns. Write a function that creates a new matrix C in the following way:

   - $C_{i,j} = \max\{A_{i,j}, B_{i,j}\}$ if $i + j < \frac{M+N}{2}$
   - $C_{i,j} = \min\{A_{i,j}, B_{i,j}\}$ if $i + j \geq \frac{M+N}{2}$

   Assume A, B, N and M are passed to your function as parameters. You may pass other parameters, too. How will you "return" C? Clearly write down the function's signature. You may write helper functions if you need them.

   Note: $X_{i,j}$ refers to the element in the i^{th} row and j^{th} column of X.

4. An inexperienced programmer wrote the following function to find the maximum elements in three different arrays, `A`, `B` and `C`:

```
void findMax(int A[], int B[], int C[])
{
    int maxA = A[0], maxB = B[0], maxC = C[0];
    for(int i=1;i<MAX_LEN;i++)
    {
        if(maxA < A[i]) maxA = A[i];
        if(maxB < B[i]) maxB = B[i];
        if(maxC < C[i]) maxC = C[i];
    }
}
```

   The problem, however, is that the programmer did not know how to return all three values (without adding extra parameters). Can you extend this code to return `maxA`, `maxB` and `maxC`? You cannot add more parameters, but you may change the return type, and you may write code outside the function too.

5. Write a class that represents an Athlete. Assume this athlete runs only 100m races. The class should have the following properties: *name* and *best time*.

   You have to write the class definition, getters and setters for all properties, and the following functions:

   - An constructor that sets the name and best time. You should think of the signature yourself.
   - `int position(Athlete array[], int num)`.
     This function takes an array (of length `num`) of other Athelete objects (it does not contain this athlete), and finds this athlete's rank amongst all `num + 1` athletes. An athlete with the lowest best time ranks 1, and that with the highest best time ranks `num + 1`.

   Your code should demonstrate separation of interface and implementation.

6. The students of CSCI 135 are trying to write their own string class. Below is a portion of their interface code.

```
/* String135.h */
class String135
{
private:
    char chrArray[MAX_LEN];
    int len;

public:
    ...
    /* inserts the character c at position i, and moves the rest (after i)
       to the right. If the last character is out of bounds, it is removed.
       It also updates len. The function returns true in this case.
       If i is out of bounds, or it's beyond the length of the current
       string, nothing changes and false is returned */
    bool insert(int i, char c);
};
```

   You are supposed to help them with the implementation. Write down the implementation for the function `void insert(int i, char c)`. You may not add any more member variables, and assume you are writing this function in the implementation file.

7. Assume you are given the matrix A, with n columns and m rows. Define $S_A[i;j] = \sum_{a=0}^{i}\sum_{b=0}^{j} A_{a,b}$ (i.e., $S_A[i;j]$ is the sum of the $(i+1)\times(j+1)$ submatrix of A starting at the top left corner). Write a function `subMatrixSum(...)` that fills an $n \times m$ matrix C such that $C_{i,j} = S_A[i;j]$. For **example**, given the matrix

$$A = \begin{bmatrix} 4 & 7 & 0 & 2 \\ -1 & 8 & 3 & 5 \\ 9 & 9 & 1 & -2 \\ 3 & 2 & 1 & 4 \end{bmatrix}, \text{ we have } C = \begin{bmatrix} 4 & 11 & 11 & 13 \\ 3 & 18 & 21 & 28 \\ 12 & 36 & 40 & 45 \\ 15 & 41 & 46 & 55 \end{bmatrix}$$

because $S_A[0;0] = 4$, $S_A[1;1] = 18$, $S_A[2;1] = 36$, $S_A[0;3] = 13$, $S_A[3;3] = 55$, etc.

Note that you are *not* required to write a Matrix class. Just use the usual representation of a matrix. You can choose the function's parameters yourself, but write the signature clearly.

Hint: first write a function that computes $S_A[i;j]$, and then use it in `subMatrixSum(...)`.
(13 points)

8. Design and implement a class that represents a *student*. A student has the following attributes: *name*, *ID*, *homework score*, *midterm score*, and *final score*. In your class add the usual getter and setter functions, plus the following:

   - A function to return the student's total score (which is *homework score* + *midterm score* + *final score*).
   - A function to compare this student to another student. This function takes another student object as a parameter, and returns -1 if this student's total score is lower than the parameter student's, 1 if this student's total score is greater, or 0 otherwise.

   For full credit, separate the interface and the implementation into different files and write all include statements. Write the filenames in comments. (15 points)

9. Suppose you are given the following function.

```
void compute(int A[], int B[], int N, int M)
{
    int i = 0, j = 0;
    while(i < N && j < M)
    {
        cout << "i = " << i << ", j = " << j << endl;

        if(B[j] < A[i])
            j++;
        else if(A[i] < B[j])
            i++;
        else
        {
            cout << "A[" << i << "] = B[" << j << "] = "  << A[i] << endl;
            i++;
            j++;
        }

    }
}
```

   (a) What do you think this function is computing? (1 point)

(b) Does the order of elements in `A` and `B` matter? Why or why not? (2 points)

(c) What is the output of the following code? (8 points)

```
const int N = 7;
const int M = 6;
int A[N] = {-1,0,3,6,9,12,24};
int B[M] = {0,2,5,6,14,24};

compute(A, B, N, M);
```