Shiv Nadar University

CSD101: Introduction to Computing and Programming

Quiz #2

`Max marks: 35` `30-Oct-2021`
`Time:12.00-12.40pm + 5mins (for upload)`

1. *Submit a C code file that can be compiled on the C50 platform.*
2. *DO NOT submit pdf, docx, image files. They will not be graded.*
3. *All uploads* **must be completed by 12.45pm**. *Late submissions may not be graded.*

1. You are given an $m \times n$ matrix of integer numbers - note that the matrix can contain positive, negative and zero entries. Write a C program (using the template given on the next page) that finds the sub-matrix that has the maximum value for the sum of its entries. If more than one sub-matrix has the same value then output the one with the fewest entries. If the number of entries are also the same then output any one of them.

   Note that a sub-matrix is one that has contiguous rows and columns from the original matrix. It can be represented by $(r_1, c_1), (r_2, c_2)$ where $r_1 \leq r_2$ and $c_1 \leq c_2$. (r_1, c_1) is the top-left corner entry and (r_2, c_2) is the bottom-right corner entry of the sub-matrix.

   For example, consider the matrix:

   $$\begin{bmatrix} 3 & 1 & -5 & 2 \\ 10 & 0 & 3 & 1 \\ -6 & 4 & 11 & -7 \end{bmatrix}$$

   The sub-matrix with the maximum value for the sum of entries is:

   $$\begin{bmatrix} 10 & 0 & 3 \\ -6 & 4 & 11 \end{bmatrix}$$

   The maximum value is 22.

   Another example: suppose the matrix is:

   $$\begin{bmatrix} -1 & 4 \\ -2 & -3 \\ -5 & -6 \end{bmatrix}$$

   The maximum value sub-matrix is 4 and the maximum value is also 4.

   Your C code must use the template given below.

   Fill in the code for the functions `readMatrix` and `printMatrix`. Then fill in the code below the comment line `//Code for ...` in the `main` function. Some declarations and code are already present in `main`. You should use them. Make any additional declarations that you need at the location indicated by the comment.

The template starts below.

```
#include <stdio.h>
#include <stdlib.h>
#define N 10

void readMatrix(int arr[][N], int rows, int cols) {
   //Reads matrix row wise.
}

void printMatrix(int arr[][N], int r1, int r2, int c1, int c2) {
   /* Prints the sub-matrix from r1,c1 to r2,c2. r1<=r2; c1<=c2 */
}

int main() {
   int arr[N][N];
   int rows, cols;//number of rows and cols in matrix
   int mr1, mc1, mr2, mc2;//boundaries of maximal value sub-matrix
   int mval;//Value of maximal submatrix
   int noOfentries;//number of entries in maximal submatrix
   //Put any added declarations that you may need below

   printf("Give number of rows and cols. Should be >0, <=10 = ");
   scanf("%d%d",&rows, &cols);//reads number of rows, cols
   //Code for reading matrix

   //Code for finding the maximal value sub-matrix

   printf("\nMaximal Sub-matrix\n\n");
   //Code for printing sub-matrix and max value

   exit(0);
}
```

Solution:

```
#include <stdio.h>
#include <stdlib.h>
#define N 10

void readMatrix(int arr[][N], int rows, int cols) {
   //Reads matrix row wise.
   int r,c;
   for (r=0; r<rows; r++)
      for (c=0; c<cols; c++)
         scanf("%d",&arr[r][c]);
   return;
}

void printMatrix(int arr[][N], int r1, int r2, int c1, int c2) {
   /* Prints the sub-matrix from r1,c1 to r2,c2. r1<=r2; c1<=c2 */
   int r,c;
   for (r=r1; r<=r2; r++) {
      for(c=c1; c<=c2; c++)
         printf("%d ",arr[r][c]);
      printf("\n");
   }
   return;
}

int main() {
   int arr[N][N];
   int rows, cols;//number of rows and cols in matrix
   int mr1, mc1, mr2, mc2;//boundaries of maximal value sub-matrix
   int mval;//Value of maximal submatrix - initialized to arr[0][0]
   int noOfentries;//number of entries in maximal submatrix
   int r1, r2, c1, c2, val;//index variables for iteration, value of sub-matrix
   printf("Give number of rows and cols. Should be >0, <=10 = ");
   //Code for reading rows, cols and matrix
   scanf("%d%d",&rows, &cols);
   readMatrix(arr,rows,cols);
   //Code for finding the maximal value sub-matrix
   mr1=mr2=mc1=mc2=0;
   mval=arr[0][0]; noOfentries=1;
   for (r1=0; r1<rows; r1++) {
      for (r2=r1; r2<rows; r2++) {
         for (c1=0; c1<cols; c1++) {
            for (c2=c1; c2<cols; c2++) {
               //Finds sum of sub-matrix entries
               val=0;
```

```
                for (int r=r1; r<=r2; r++)
                   for (int c=c1; c<=c2; c++)
                      val+=arr[r][c];
                if (val>mval || (val==mval && ((r2-r1+1)*(c2-c1+1)<noOfentries))) {
                   mval=val;
                   mr1=r1; mr2=r2;
                   mc1=c1; mc2=c2;
                   noOfentries=(r2-r1+1)*(c2-c1+1);
                }
             }
          }
       }
   }
   //Code for printing sub-matrix and max value
   printf("\nMaximal Sub-matrix\n\n");
   printMatrix(arr,mr1,mr2,mc1,mc2);
   printf("Max value = %d\n",mval);
   exit(0);
}
```

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