Project 1 (in c++): Histogrm and thresholding. Given a grey-scale image, you are to perform the following tasks:

1. Compute histogram of the input image and display the histogram in two formats, see the output description below.

2. Perform binary threshold operation on the input image with a given threshold value via argv[].

3. Output the result of the threshold in two formats, see the output description below.

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Language: C++
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Project points: 10 pts
Due Date: Soft copy (*.zip) and hard copies (*.pdf):
+1 (11/10 pts): early submission, 2/10/2022, Thursday before midnight
-0 (10/10 pts): on time, 2/13/2022 Sunday before midnight
-1 (9/10 pts): 1 day late, 2/14/2022 Monday before midnight
-2 (8/10 pts): 2 days late, 2/15/2022 Tuesday before midnight
(-10/10 pts): non-submission, 2/15/2022 Tuesday after midnight

*** Name your soft copy and hard copy files using the naming convention as given in
the project submission requirement discussed in a lecture and is posted in Black Board.

*** All on-line submission MUST include Soft copy (*.zip) and hard copy (*.pdf) in **the same email attachments** with correct email subject as stated in the email requirement; otherwise, your submission will be rejected.

1. Run your program on data1 with threshold 6
2. Run your program on data2 with threshold 30.
3. Include in your hard copy *.pdf file as follows:
   - Cover page.
   - source code.
   - Output outFile1 for data 1.
   - Output outFile2 for data 1.
   - Output outFile3 for data 1.
   - Output outFile4 for data 1.
   - Output outFile1 for data 2.
   - Output outFile2 for data 2.
   - Output outFile3 for data 2.
   - Output outFile4 for data 2.

****
I. Input: There are two inputs to the program.
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a) inFile (argv[1]):
a txt file representing a grey-scale image, where
the first text line (4 integers) is the "header" of the input image then follows by rows and cols of integers.

For example,

```
4  6  1 12    // image has 4 rows,6 cols, min is 1, max is 12
2  3  4 11  2  9
5  6 11  2 10  7
1  1 12  1  9  9
4  5  6  9  9  9
```

b) a threshold value : from argv[2]

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II. Outputs: There are four output files.

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a) OutFile1 (use argv[3]): For the output of histogram in the following format (to be used in the future project):
The first text-line is the image header, follows by a list of pairs <i, j> where i = 0 to max and j is the hist(i)
For example:

```
4 6 1 12
0  0
1  3
2  3
3  1
4  2
5  2
6  2
7  1
8  0
9  6
10 1
11 2
12 1
```

b) OutFile2 (use argv[4]): Display the histogram (for visual) as follows:
first text line is the image header then follows by a list of : greyScale (numpixels): number of +'s
for example, the output of the histogram of the above image would be:
Use the maximum of 70 +'s for all counts greater than 70. Use small font size so that 70 +'s can be printed on one text line.

```
4 6 1 12
0  (0):
1  (3):+++
2  (3):+++
3  (1):+
4  (2):++
5  (2):++
6  (2):++
7  (1):+
8  (0):
9  (6):++++++
10 (1):+
11 (2):++
12 (1):+
```

c) outFile3 (use argv[5]): The result of the threshold of the input image. (To be used for future processing.)
Note: The output binary image also needs to have the image header.
For example, given the above image and 6 as the threshold value

then the binary image would be:

```
4 6 0 1          // notice the min and max values have changed 0 and 1.
0 0 0 1 0 1
0 1 1 0 1 1
0 0 1 0 1 1
0 0 1 1 1 1
```

d) outFile4 (use argv[6]): (For nice visual purposes).
For example, given the above threshold image, the pretty print replace 0 with a period.

```
4 6 0 1
. . . 1 . 1
. 1 1 . 1 1
. . 1 . 1 1
. . 1 1 1 1
```

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III. Data structure:
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- image class
  - numRows (int)
  - numCols (int)
  - minVal (int)
  - maxVal (int)
  - histAry(int*) //a 1D integer array, size of maxVal + 1
    // need to be dynamically allocated at run time
  - thresholdValue (int) // via argv[2]

  Methods:

  - computeHist(...) // See algorithm below.
  - printHist (...)// on your own; see the above example
  - dispHist (...)// on your own; see the above example
  - threshold(...) // The algorithm is given below

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IV. main (...)
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step 0: inFile ← open input file use argv[1]
open all 4 outFiles via argv[3], argv[4], argv[5], argv[6]

step 1: numRows, numCols, minVal, maxVal ← read from inFile

step 2: histAry ← dynamically allocate and initialize to 0

step 3: ComputeHist (inFile)

step 4: printHist(outFile1)

Step 5: dispHist (outFile2)

step 6: close inFile
reopen inFile

```
Step 7: thrVal ← get from argv[2]
        outFile3 ← "The threshold value uses is " thrVal
        outFile4 ← "The threshold value uses is " thrVal

Step 8: threshold (inFile, outFile3, outFile4, thrVal)

step 9: close all files

************************************************
V. ComputeHist (inFile)
************************************************
Step 1: val ← read one pixel from inFile
Step 2: histAry [val} ++
Ste[ 3: repeat step 1 to step 2 while inFile is not empty

************************************************
V. threshold (inFile, outFile3, outFile4, thrVal)
************************************************
Step 0: minVal ← 0
        maxVal ← 1

Step 1: outFile3, outFile4 ← output numRows, numCols, minVal and maxVal

Step 2: pixelVal← read from inFile one integer at a time

Step 3: if pixelVal >= thrVal
               outFile3 <-- write 1 follows by a blank
               outFile4 <-- write 1 follows by a blank
        else
               outFile3 <-- write 0 follows by a blank
               outFile4 <-- write . follows by a blank

Step 4: repeat step 2 to 3 until the inFile is empty
```