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Section: 224

Project #: 1

Project Name: Bi-Means automatic threshold selection

Due Date: 2/20/2024

**Algorithm steps**

**SinnerineS\_Project1\_Main (…)**

Step 0: inFile1, outFile1, outFile2, deBugFile  open via args []

Step 1: numRows, numCols, minVal, maxVal  read from inFile1.

\*\*\*> histHeight 🡨 loadHist (histAry, inFile) // loadHist ( ) returns the largest value of input histogram. dynamically allocate histAry, GaussAry, Graph with proper size and proper initializations.

Step 2: outFile1 🡨 “in main (), below is the input histogram”

dispHist (histAry, outFile1)

Step 3: plotHist (histAry, Graph)

deBugFile 🡨 “In main (), below is the Graph after plotting the histogram onto Graph”

deBugFile 🡨print the Graph to deBugFile.

Step 4: BiGaussThrVal  biGaussian (histAry, GaussAry, maxHeight, minVal, maxVal, Graph, deBugFile)

Step 5: outFile2 🡨 “The BiGaussThrVal is” print BiGaussThrVal

Step 6: plotGaussCurves (histAry, histHeight, BiGaussThrVal, minVal, maxVal, Graph, deBugFile)

Step 7: outFile2 🡨 “In main(). Below is the graph showing the histogram, the best fitted Gaussian curves and the gap”

outFile2 🡨output Graph

Step 8: close all files

**Source Code**

#include <iostream>

#include <fstream>

#include <cmath>

#include <iomanip>

using namespace std;

class ThresholdSelection {

public:

int numRows, numCols, minVal, maxVal;

int BiGaussThrVal;

int histHeight;

int maxHeight;

int \*histAry;

int \*GaussAry;

int \*bestFitGaussAry;

char \*\*Graph;

public:

// Constructor - dynamically allocates all member arrays and initialization

ThresholdSelection(int rows, int cols, int min, int max) {

numRows = rows;

numCols = cols;

minVal = min;

maxVal = max;

BiGaussThrVal = 0;

histHeight = 0;

maxHeight = 0;

bestFitGaussAry = new int[maxVal + 1]();

}

// Reads and loads the histAry from inFile and returns the max count.

int loadHist(int \*histAry, ifstream &inFile) {

int maxCount = 0;

for (int i = 0; i <= maxVal; ++i) {

histAry[i] = 0; // Initialize all counts to zero

}

int index, count;

while (inFile >> index >> count) {

if (index >= minVal && index <= maxVal) {

histAry[index] = count;

if (count > maxCount) {

maxCount = count;

}

}

}

return maxCount;

}

// Outputs the histogram in the specified format

void dispHist(int \*histAry, ofstream &outfile) {

outfile << numRows << " " << numCols << " " << minVal << " " << maxVal << endl;

for (int i = minVal; i <= maxVal; ++i) {

outfile << i << " (" << histAry[i] << "): ";

for (int j = 0; j < histAry[i]; ++j) {

outfile << "+";

}

outfile << endl;

}

}

// Copies ary1 to ary2

void copyArys(int \*ary1, int \*ary2) {

for (int i = 0; i <= maxVal; ++i) {

ary2[i] = ary1[i];

}

}

// Plots the histogram onto Graph with ‘+’

void plotHist(int \*histAry, char \*\*Graph) {

for (int i = 0; i <= maxVal; ++i) {

for (int j = 0; j < histAry[i]; ++j)

Graph[i][j] = '+';

}

}

// Plots the two best fit Gaussian curves and the gaps between the two curves and histogram

// with symbols (\* for points on the curve and ^ for the gaps) onto graph.

void plotGaussCurves(int \*histAry, int \*bestFitGaussAry, int maxVal, char \*\*Graph, ofstream &deBugFile) {

deBugFile << "Entering plotGaussCurves() method" << endl;

for (int index = 0; index <= maxVal; ++index) {

int end1, end2;

if (bestFitGaussAry[index] <= histAry[index]) {

end1 = bestFitGaussAry[index];

end2 = histAry[index];

} else {

end1 = histAry[index];

end2 = bestFitGaussAry[index];

}

int i = end1;

while (i <= end2) {

Graph[index][i] = '#';

i++;

}

Graph[index][bestFitGaussAry[index]] = '\*';

}

deBugFile << "Leaving plotGaussCurves()" << endl;

}

// Sets 1D Ary to zero;

void setZero(int \*Ary) {

for (int i = 0; i <= maxVal; ++i)

Ary[i] = 0;

}

// The method determines the best threshold selection (via fitGauss method)

// where the two Gaussian curves fit the histogram the best

int biGaussian(int \*histAry, int \*GaussAry, int &maxHeight, int minVal, int maxVal, char \*\*Graph, ofstream &deBugFile) {

deBugFile << "Entering biGaussian method" << endl;

double sum1, sum2, total, minSumDiff = 99999.0;

int offSet = (maxVal - minVal) / 10;

int dividePt = offSet;

int bestThr = dividePt;

while (dividePt < (maxVal - offSet)) {

setZero(GaussAry);

sum1 = fitGauss(0, dividePt, histAry, GaussAry, maxHeight, Graph, deBugFile);

sum2 = fitGauss(dividePt, maxVal, histAry, GaussAry, maxHeight, Graph, deBugFile);

total = sum1 + sum2;

if (total < minSumDiff) {

minSumDiff = total;

bestThr = dividePt;

copyArys(GaussAry, bestFitGaussAry);

}

deBugFile << "In biGaussian(): dividePt = " << dividePt << ", sum1 = " << sum1 << ", sum2 = " << sum2 << ", total = " << total << ", minSumDiff = " << minSumDiff << " and bestThr = " << bestThr << endl;

dividePt++;

}

deBugFile << "Leaving biGaussian method, minSumDiff = " << minSumDiff << ", bestThr is " << bestThr << endl;

return bestThr;

}

// Computes the Gaussian curve fitting to the histogram

double fitGauss(int leftIndex, int rightIndex, int \*histAry, int \*GaussAry, int &maxHeight, char \*\*Graph, ofstream &deBugFile) {

deBugFile << "Entering fitGauss method" << endl;

double mean, var, sum = 0.0, Gval;

mean = computeMean(leftIndex, rightIndex, maxHeight, histAry, deBugFile);

var = computeVar(leftIndex, rightIndex, mean, histAry, deBugFile);

for (int index = leftIndex; index <= rightIndex; ++index) {

Gval = modifiedGauss(index, mean, var, maxHeight);

sum += abs(Gval - static\_cast<double>(histAry[index]));

GaussAry[index] = static\_cast<int>(Gval);

}

deBugFile << "Leaving fitGauss method, sum is: " << sum << endl;

return sum;

}

// Computes the mean from leftIndex to rightIndex of the histogram

// and returns the \*weighted\* average of the histogram; i.e., i \* hist[i]

double computeMean(int leftIndex, int rightIndex, int &maxHeight, int \*histAry, ofstream &deBugFile) {

deBugFile << "Entering computeMean method" << endl;

double sum = 0.0;

int numPixels = 0;

for (int index = leftIndex; index <= rightIndex; ++index) {

sum += histAry[index] \* index;

numPixels += histAry[index];

if (histAry[index] > maxHeight) {

maxHeight = histAry[index];

}

}

double result = sum / numPixels;

deBugFile << "Leaving computeMean() method, maxHeight is: " << maxHeight << ", result is: " << result << endl;

return result;

}

// Computes the \*weighted\* variance from the given leftIndex to rightIndex of the histogram

// and returns the \*weighted\* variance

double computeVar(int leftIndex, int rightIndex, double mean, int \*histAry, ofstream &deBugFile) {

deBugFile << "Entering computeVar() method" << endl;

double sum = 0.0;

int numPixels = 0;

for (int index = leftIndex; index <= rightIndex; ++index) {

sum += histAry[index] \* pow(index - mean, 2);

numPixels += histAry[index];

}

double result = sum / numPixels;

deBugFile << "Leaving computeVar method, returning result: " << result << endl;

return result;

}

// Uses the given mean and variance to compute the Gaussian value based on the modified Gaussian function

double modifiedGauss(int x, double mean, double var, int &maxHeight) {

double Gval = maxHeight \* exp(-pow(x - mean, 2) / (2 \* var));

return Gval;

}

};

int main(int argc, char \*argv[]) {

if (argc != 5) {

cerr << "Arguments must include: <inFile1> <outFile1> <outFile2> <deBugFile>" << endl;

return 1;

}

ifstream inFile(argv[1]);

ofstream outFile1(argv[2]);

ofstream outFile2(argv[3]);

ofstream deBugFile(argv[4]);

if (!inFile.is\_open() || !outFile1.is\_open() || !outFile2.is\_open() || !deBugFile.is\_open()) {

cerr << "Error: Unable to open files." << endl;

return 1;

}

int numRows, numCols, minVal, maxVal;

inFile >> numRows >> numCols >> minVal >> maxVal;

// Create an instance of the ThresholdSelection class

ThresholdSelection thresholdSelection(numRows, numCols, minVal, maxVal);

int \*histAry = new int[maxVal + 1]();

int histHeight = thresholdSelection.loadHist(histAry, inFile);

// Dynamically allocate GaussAry and Graph

int \*GaussAry = new int[maxVal + 1]();

char \*\*Graph = new char\*[maxVal + 1];

for (int i = 0; i <= maxVal; ++i) {

Graph[i] = new char[histHeight + 1]();

}

// output input histogram

outFile1 << "In main (), below is the input histogram:" << endl;

thresholdSelection.dispHist(histAry, outFile1);

// plot histogram

thresholdSelection.plotHist(histAry, Graph);

deBugFile << "In main (), below is the Graph after plotting the histogram onto Graph" << endl;

// Print graph to debug file

for (int i = 0; i <= maxVal; ++i) {

for (int j = 0; j <= histHeight; ++j) {

deBugFile << Graph[i][j];

}

deBugFile << endl;

}

// compute BiGaussThrVal

int BiGaussThrVal = thresholdSelection.biGaussian(histAry, GaussAry,

thresholdSelection.maxHeight, thresholdSelection.minVal,

thresholdSelection.maxVal,Graph,

deBugFile);

// output BiGaussThrVal

outFile2 << "The BiGaussThrVal is " << BiGaussThrVal << endl;

// plot Gaussian curves

thresholdSelection.plotGaussCurves(histAry, thresholdSelection.bestFitGaussAry,

thresholdSelection.maxVal, Graph, deBugFile);

// output graph showing histogram, best fitted Gaussian curves, and gap

outFile2 << "In main(). Below is the graph showing the histogram, the best fitted Gaussian curves, and the gap:" << endl;

// Print graph to outFile2

for (int i = 0; i <= maxVal; ++i) {

for (int j = 0; j <= histHeight; ++j) {

outFile2 << Graph[i][j];

}

outFile2 << endl;

}

// close files

inFile.close();

outFile1.close();

outFile2.close();

deBugFile.close();

return 0;

}

**Program Output**

**outFile1.txt for histogram 1**

In main (), below is the input histogram:

64 64 0 63

0 (10): ++++++++++

1 (14): ++++++++++++++

2 (17): +++++++++++++++++

3 (20): ++++++++++++++++++++

4 (22): ++++++++++++++++++++++

5 (31): +++++++++++++++++++++++++++++++

6 (28): ++++++++++++++++++++++++++++

7 (33): +++++++++++++++++++++++++++++++++

8 (45): +++++++++++++++++++++++++++++++++++++++++++++

9 (56): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++

10 (70): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

11 (90): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

12 (120): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

13 (150): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

14 (192): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

15 (210): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

16 (192): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

17 (172): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

18 (132): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

19 (100): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

20 (89): +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

21 (78): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

22 (42): ++++++++++++++++++++++++++++++++++++++++++

23 (20): ++++++++++++++++++++

24 (18): ++++++++++++++++++

25 (10): ++++++++++

26 (9): +++++++++

27 (8): ++++++++

28 (8): ++++++++

29 (7): +++++++

30 (6): ++++++

31 (5): +++++

32 (4): ++++

33 (4): ++++

34 (6): ++++++

35 (8): ++++++++

36 (10): ++++++++++

37 (12): ++++++++++++

38 (22): ++++++++++++++++++++++

39 (26): ++++++++++++++++++++++++++

40 (40): ++++++++++++++++++++++++++++++++++++++++

41 (45): +++++++++++++++++++++++++++++++++++++++++++++

42 (72): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

43 (80): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

44 (90): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

45 (100): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

46 (120): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

47 (150): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

48 (188): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

49 (190): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

50 (170): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

51 (140): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

52 (120): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

53 (110): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

54 (90): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

55 (80): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

56 (70): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

57 (60): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

58 (30): ++++++++++++++++++++++++++++++

59 (20): ++++++++++++++++++++

60 (12): ++++++++++++

61 (9): +++++++++

62 (8): ++++++++

63 (6): ++++++

**outFile2.txt for histogram 1**

The BiGaussThrVal is 32

In main(). Below is the graph showing the histogram, the best fitted Gaussian curves, and the gap:

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**deBugFile.txt for histogram 1**

In main (), below is the Graph after plotting the histogram onto Graph

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Entering biGaussian method

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 31, result is: 3.65493

Entering computeVar() method

Leaving computeVar method, returning result: 3.52177

Leaving fitGauss method, sum is: 50.436

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 32.9465

Entering computeVar() method

Leaving computeVar method, returning result: 300.789

Leaving fitGauss method, sum is: 5238.64

In biGaussian(): dividePt = 6, sum1 = 50.436, sum2 = 5238.64, total = 5289.07, minSumDiff = 5289.07 and bestThr = 6

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 4.28571

Entering computeVar() method

Leaving computeVar method, returning result: 4.5698

Leaving fitGauss method, sum is: 864.191

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 33.1373

Entering computeVar() method

Leaving computeVar method, returning result: 297.741

Leaving fitGauss method, sum is: 5197.59

In biGaussian(): dividePt = 7, sum1 = 864.191, sum2 = 5197.59, total = 6061.79, minSumDiff = 5289.07 and bestThr = 6

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 5.04545

Entering computeVar() method

Leaving computeVar method, returning result: 5.87975

Leaving fitGauss method, sum is: 946.262

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 33.3573

Entering computeVar() method

Leaving computeVar method, returning result: 294.449

Leaving fitGauss method, sum is: 5159.17

In biGaussian(): dividePt = 8, sum1 = 946.262, sum2 = 5159.17, total = 6105.43, minSumDiff = 5289.07 and bestThr = 6

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 5.84783

Entering computeVar() method

Leaving computeVar method, returning result: 7.21597

Leaving fitGauss method, sum is: 1004.45

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 33.6517

Entering computeVar() method

Leaving computeVar method, returning result: 290.316

Leaving fitGauss method, sum is: 5136.09

In biGaussian(): dividePt = 9, sum1 = 1004.45, sum2 = 5136.09, total = 6140.54, minSumDiff = 5289.07 and bestThr = 6

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 6.68786

Entering computeVar() method

Leaving computeVar method, returning result: 8.53841

Leaving fitGauss method, sum is: 1035.8

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 34.0131

Entering computeVar() method

Leaving computeVar method, returning result: 285.532

Leaving fitGauss method, sum is: 5126.12

In biGaussian(): dividePt = 10, sum1 = 1035.8, sum2 = 5126.12, total = 6161.92, minSumDiff = 5289.07 and bestThr = 6

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 7.57798

Entering computeVar() method

Leaving computeVar method, returning result: 9.8219

Leaving fitGauss method, sum is: 1033.5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 34.4613

Entering computeVar() method

Leaving computeVar method, returning result: 279.898

Leaving fitGauss method, sum is: 5139.12

In biGaussian(): dividePt = 11, sum1 = 1033.5, sum2 = 5139.12, total = 6172.63, minSumDiff = 5289.07 and bestThr = 6

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 8.53237

Entering computeVar() method

Leaving computeVar method, returning result: 11.0115

Leaving fitGauss method, sum is: 988.936

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 35.0383

Entering computeVar() method

Leaving computeVar method, returning result: 272.912

Leaving fitGauss method, sum is: 5150.54

In biGaussian(): dividePt = 12, sum1 = 988.936, sum2 = 5150.54, total = 6139.48, minSumDiff = 5289.07 and bestThr = 6

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 9.48159

Entering computeVar() method

Leaving computeVar method, returning result: 12.0117

Leaving fitGauss method, sum is: 957.849

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 35.8192

Entering computeVar() method

Leaving computeVar method, returning result: 263.562

Leaving fitGauss method, sum is: 5124.62

In biGaussian(): dividePt = 13, sum1 = 957.849, sum2 = 5124.62, total = 6082.47, minSumDiff = 5289.07 and bestThr = 6

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 10.4477

Entering computeVar() method

Leaving computeVar method, returning result: 12.8753

Leaving fitGauss method, sum is: 909.07

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 36.8289

Entering computeVar() method

Leaving computeVar method, returning result: 251.164

Leaving fitGauss method, sum is: 5045.64

In biGaussian(): dividePt = 14, sum1 = 909.07, sum2 = 5045.64, total = 5954.71, minSumDiff = 5289.07 and bestThr = 6

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 11.3105

Entering computeVar() method

Leaving computeVar method, returning result: 13.6184

Leaving fitGauss method, sum is: 871.951

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 38.1995

Entering computeVar() method

Leaving computeVar method, returning result: 233.075

Leaving fitGauss method, sum is: 4886.36

In biGaussian(): dividePt = 15, sum1 = 871.951, sum2 = 4886.36, total = 5758.32, minSumDiff = 5289.07 and bestThr = 6

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 12.0031

Entering computeVar() method

Leaving computeVar method, returning result: 14.3754

Leaving fitGauss method, sum is: 810.234

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 39.83

Entering computeVar() method

Leaving computeVar method, returning result: 208.971

Leaving fitGauss method, sum is: 4645.22

In biGaussian(): dividePt = 16, sum1 = 810.234, sum2 = 4645.22, total = 5455.46, minSumDiff = 5289.07 and bestThr = 6

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 12.587

Entering computeVar() method

Leaving computeVar method, returning result: 15.2723

Leaving fitGauss method, sum is: 752.499

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 41.4664

Entering computeVar() method

Leaving computeVar method, returning result: 181.648

Leaving fitGauss method, sum is: 4346.81

In biGaussian(): dividePt = 17, sum1 = 752.499, sum2 = 4346.81, total = 5099.31, minSumDiff = 5099.31 and bestThr = 17

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 13.0324

Entering computeVar() method

Leaving computeVar method, returning result: 16.2284

Leaving fitGauss method, sum is: 696.344

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 43.0701

Entering computeVar() method

Leaving computeVar method, returning result: 151.745

Leaving fitGauss method, sum is: 3954.33

In biGaussian(): dividePt = 18, sum1 = 696.344, sum2 = 3954.33, total = 4650.67, minSumDiff = 4650.67 and bestThr = 18

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 13.3826

Entering computeVar() method

Leaving computeVar method, returning result: 17.2433

Leaving fitGauss method, sum is: 629.685

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 44.3981

Entering computeVar() method

Leaving computeVar method, returning result: 124.728

Leaving fitGauss method, sum is: 3515.73

In biGaussian(): dividePt = 19, sum1 = 629.685, sum2 = 3515.73, total = 4145.42, minSumDiff = 4145.42 and bestThr = 19

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 13.7111

Entering computeVar() method

Leaving computeVar method, returning result: 18.4531

Leaving fitGauss method, sum is: 558.992

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 45.4599

Entering computeVar() method

Leaving computeVar method, returning result: 101.847

Leaving fitGauss method, sum is: 3052.57

In biGaussian(): dividePt = 20, sum1 = 558.992, sum2 = 3052.57, total = 3611.56, minSumDiff = 3611.56 and bestThr = 20

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 14.015

Entering computeVar() method

Leaving computeVar method, returning result: 19.8063

Leaving fitGauss method, sum is: 527.922

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 210, result is: 46.4438

**outFile1.txt for histogram 2**

In main (), below is the input histogram:

64 64 1 60

1 (1): +

2 (3): +++

3 (5): +++++

4 (4): ++++

5 (5): +++++

6 (7): +++++++

7 (4): ++++

8 (6): ++++++

9 (10): ++++++++++

10 (12): ++++++++++++

11 (15): +++++++++++++++

12 (10): ++++++++++

13 (14): ++++++++++++++

14 (15): +++++++++++++++

15 (22): ++++++++++++++++++++++

16 (20): ++++++++++++++++++++

17 (18): ++++++++++++++++++

18 (28): ++++++++++++++++++++++++++++

19 (38): ++++++++++++++++++++++++++++++++++++++

20 (44): ++++++++++++++++++++++++++++++++++++++++++++

21 (56): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++

22 (70): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

23 (90): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

24 (120): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

25 (150): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

26 (190): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

27 (214): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

28 (190): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

29 (172): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

30 (132): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

31 (100): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

32 (89): +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

33 (78): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

34 (72): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

35 (80): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

36 (90): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

37 (100): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

38 (120): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

39 (165): +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

40 (186): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

41 (195): +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

42 (185): +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

43 (170): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

44 (165): +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

45 (120): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

46 (90): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

47 (80): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

48 (70): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

49 (60): ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

50 (54): ++++++++++++++++++++++++++++++++++++++++++++++++++++++

51 (35): +++++++++++++++++++++++++++++++++++

52 (31): +++++++++++++++++++++++++++++++

53 (21): +++++++++++++++++++++

54 (19): +++++++++++++++++++

55 (12): ++++++++++++

56 (10): ++++++++++

57 (9): +++++++++

58 (11): +++++++++++

59 (8): ++++++++

60 (6): ++++++

**outFile2.txt for histogram 2**

The BiGaussThrVal is 34

In main(). Below is the graph showing the histogram, the best fitted Gaussian curves, and the gap:

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**deBugFile.txt for histogram 2**

In main (), below is the Graph after plotting the histogram onto Graph

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Entering biGaussian method

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 5, result is: 3.5

Entering computeVar() method

Leaving computeVar method, returning result: 1.47222

Leaving fitGauss method, sum is: 4.82214

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 34.5366

Entering computeVar() method

Leaving computeVar method, returning result: 98.6523

Leaving fitGauss method, sum is: 1690.85

In biGaussian(): dividePt = 5, sum1 = 4.82214, sum2 = 1690.85, total = 1695.67, minSumDiff = 1695.67 and bestThr = 5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 4.2

Entering computeVar() method

Leaving computeVar method, returning result: 2.32

Leaving fitGauss method, sum is: 740.68

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 34.5728

Entering computeVar() method

Leaving computeVar method, returning result: 97.7023

Leaving fitGauss method, sum is: 1674.67

In biGaussian(): dividePt = 6, sum1 = 740.68, sum2 = 1674.67, total = 2415.35, minSumDiff = 1695.67 and bestThr = 5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 4.58621

Entering computeVar() method

Leaving computeVar method, returning result: 2.93222

Leaving fitGauss method, sum is: 849.647

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 34.622

Entering computeVar() method

Leaving computeVar method, returning result: 96.4641

Leaving fitGauss method, sum is: 1654.26

In biGaussian(): dividePt = 7, sum1 = 849.647, sum2 = 1654.26, total = 2503.91, minSumDiff = 1695.67 and bestThr = 5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 5.17143

Entering computeVar() method

Leaving computeVar method, returning result: 4.0849

Leaving fitGauss method, sum is: 994.573

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 34.6491

Entering computeVar() method

Leaving computeVar method, returning result: 95.8078

Leaving fitGauss method, sum is: 1646.26

In biGaussian(): dividePt = 8, sum1 = 994.573, sum2 = 1646.26, total = 2640.83, minSumDiff = 1695.67 and bestThr = 5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 6.02222

Entering computeVar() method

Leaving computeVar method, returning result: 5.71062

Leaving fitGauss method, sum is: 1141.63

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 34.6885

Entering computeVar() method

Leaving computeVar method, returning result: 94.8985

Leaving fitGauss method, sum is: 1634.32

In biGaussian(): dividePt = 9, sum1 = 1141.63, sum2 = 1634.32, total = 2775.95, minSumDiff = 1695.67 and bestThr = 5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 6.85965

Entering computeVar() method

Leaving computeVar method, returning result: 7.1382

Leaving fitGauss method, sum is: 1249.98

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 34.7519

Entering computeVar() method

Leaving computeVar method, returning result: 93.4998

Leaving fitGauss method, sum is: 1613.21

In biGaussian(): dividePt = 10, sum1 = 1249.98, sum2 = 1613.21, total = 2863.19, minSumDiff = 1695.67 and bestThr = 5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 7.72222

Entering computeVar() method

Leaving computeVar method, returning result: 8.4784

Leaving fitGauss method, sum is: 1336.21

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 34.8255

Entering computeVar() method

Leaving computeVar method, returning result: 91.952

Leaving fitGauss method, sum is: 1589.04

In biGaussian(): dividePt = 11, sum1 = 1336.21, sum2 = 1589.04, total = 2925.25, minSumDiff = 1695.67 and bestThr = 5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 8.2439

Entering computeVar() method

Leaving computeVar method, returning result: 9.40393

Leaving fitGauss method, sum is: 1425.23

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 34.9143

Entering computeVar() method

Leaving computeVar method, returning result: 90.1708

Leaving fitGauss method, sum is: 1559.65

In biGaussian(): dividePt = 12, sum1 = 1425.23, sum2 = 1559.65, total = 2984.88, minSumDiff = 1695.67 and bestThr = 5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 8.9375

Entering computeVar() method

Leaving computeVar method, returning result: 10.8503

Leaving fitGauss method, sum is: 1522.16

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 34.9714

Entering computeVar() method

Leaving computeVar method, returning result: 89.0841

Leaving fitGauss method, sum is: 1544.02

In biGaussian(): dividePt = 13, sum1 = 1522.16, sum2 = 1544.02, total = 3066.18, minSumDiff = 1695.67 and bestThr = 5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 9.62162

Entering computeVar() method

Leaving computeVar method, returning result: 12.3794

Leaving fitGauss method, sum is: 1617.76

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 35.0483

Entering computeVar() method

Leaving computeVar method, returning result: 87.7004

Leaving fitGauss method, sum is: 1528.05

In biGaussian(): dividePt = 14, sum1 = 1617.76, sum2 = 1528.05, total = 3145.81, minSumDiff = 1695.67 and bestThr = 5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 10.5113

Entering computeVar() method

Leaving computeVar method, returning result: 14.3251

Leaving fitGauss method, sum is: 1704.67

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 35.1275

Entering computeVar() method

Leaving computeVar method, returning result: 86.3566

Leaving fitGauss method, sum is: 1514.19

In biGaussian(): dividePt = 15, sum1 = 1704.67, sum2 = 1514.19, total = 3218.86, minSumDiff = 1695.67 and bestThr = 5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 11.2288

Entering computeVar() method

Leaving computeVar method, returning result: 15.8758

Leaving fitGauss method, sum is: 1783.57

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 35.2392

Entering computeVar() method

Leaving computeVar method, returning result: 84.5746

Leaving fitGauss method, sum is: 1503.81

In biGaussian(): dividePt = 16, sum1 = 1783.57, sum2 = 1503.81, total = 3287.38, minSumDiff = 1695.67 and bestThr = 5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 11.8363

Entering computeVar() method

Leaving computeVar method, returning result: 17.3416

Leaving fitGauss method, sum is: 1866.52

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 35.3368

Entering computeVar() method

Leaving computeVar method, returning result: 83.1166

Leaving fitGauss method, sum is: 1496.97

In biGaussian(): dividePt = 17, sum1 = 1866.52, sum2 = 1496.97, total = 3363.49, minSumDiff = 1695.67 and bestThr = 5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 12.7035

Entering computeVar() method

Leaving computeVar method, returning result: 19.495

Leaving fitGauss method, sum is: 1943.24

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 35.4209

Entering computeVar() method

Leaving computeVar method, returning result: 81.9487

Leaving fitGauss method, sum is: 1486.21

In biGaussian(): dividePt = 18, sum1 = 1943.24, sum2 = 1486.21, total = 3429.45, minSumDiff = 1695.67 and bestThr = 5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 13.7131

Entering computeVar() method

Leaving computeVar method, returning result: 21.7067

Leaving fitGauss method, sum is: 1992.83

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 35.5461

Entering computeVar() method

Leaving computeVar method, returning result: 80.3413

Leaving fitGauss method, sum is: 1486.29

In biGaussian(): dividePt = 19, sum1 = 1992.83, sum2 = 1486.29, total = 3479.11, minSumDiff = 1695.67 and bestThr = 5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 14.6975

Entering computeVar() method

Leaving computeVar method, returning result: 23.5277

Leaving fitGauss method, sum is: 2018.49

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 35.709

Entering computeVar() method

Leaving computeVar method, returning result: 78.41

Leaving fitGauss method, sum is: 1503.75

In biGaussian(): dividePt = 20, sum1 = 2018.49, sum2 = 1503.75, total = 3522.24, minSumDiff = 1695.67 and bestThr = 5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 15.7448

Entering computeVar() method

Leaving computeVar method, returning result: 25.1218

Leaving fitGauss method, sum is: 2013.86

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 35.8902

Entering computeVar() method

Leaving computeVar method, returning result: 76.4354

Leaving fitGauss method, sum is: 1529.94

In biGaussian(): dividePt = 21, sum1 = 2013.86, sum2 = 1529.94, total = 3543.81, minSumDiff = 1695.67 and bestThr = 5

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 16.8206

Entering computeVar() method

Leaving computeVar method, returning result: 26.3732

Leaving fitGauss method, sum is: 1977.61

Entering fitGauss method

Entering computeMean method

Leaving computeMean() method, maxHeight is: 214, result is: 36.112