CV Project 6: Image Compression via DT C++

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Algorithmic Steps:

1. Open the input file and the output1 file
2. Assign all the variables numsrow, numscol, imgmax and imgmin from the input file 3. Open the 2nd output file with the name as name of input file + “skeleton” (input.txt_skeleton). Similary, open the 3rd output file with the name as name of input file + “decompressed” (input.txt_decompressed).
4. Dynamically allocate the ZFArray and the SkeletonArray with numrows + 2 and numcols + 2 as the dimensions. Call the method setZero(int** ary) to initialize all the values of the ZFArray to 0. Similarly, call setZero once again to do the same for skeletonarray.
5. Call the method loadimage(..) to load the content of the input.txt to the ZFArray 6. Call the function Compute8Distance(..). This function first calls the computefirstpass (to compute the first pass of compression via dt) then reformatpretty print, then computesecondpass to compute the second pass of the image for compression. Then it agains call the method reformatprettyprint to output the result to the outputfile1
7. Call the function imagecompresser. This function calls the function localmaxima to calculate the localmaxima of the result of the 2nd pass of image compression. Then the parent method calls the reformatprettyprint. And finally calls the method extractskeleton that stores the compressed image in skeletonfile (loseless compression)
8. Close and reopen the skeleton file (to make it as an input file, which will be used to extract the image)
9. Set all the element positions of the ZFArray to 0 by calling the method setzero(..) 10. Call the function loadskeleton that loads the contents of the file rendered by the skeleton compression
11. Then call the function imagedecompression(..) that calls the function firstpassexpansion to perform expansion pass 1. Then call the function reformatprettyprint. Then call the function secondpassexpansion to perform the expansion pass 2. Then again call the function reformatprettyprint to output the result to the outputfile1
12. Output the image header to the file, “input.txt_decompressed”.
13. Then call the function threshold to change all the pixel values >= 1 to 1 and < 1 to 0 14. Finally, close all the input files

Source Code:

Main:

```
# include<fstream>
# include <iostream>
#include <string>
#include "ImageCompression.cpp"
```

```
using namespace std;

int main(int argc, char** argv)
{
	if (argc != 3)
	{
		std::cout << "Wrong number of arguments\n";
		std::cout << "argc = " << argc << std::endl;
		exit(0);
	}
	int numRows = 0, numCols = 0, minval = 0, maxval = 0;

	ifstream inFile, skfile;

	ofstream outFile(argv[2]);

	std::string subname = "_skelelton.txt";
	std::string subname2 = "_decompressed.txt";

	ofstream outFile2(argv[1] + subname), outFile3(argv[1] + subname2);

	inFile.open(argv[1]);

	if (inFile.fail()) cout << "Error in opening " << argv[1] << "\n";



	inFile >> numRows; inFile >> numCols; inFile >> minval; inFile >> maxval;

	std::string header = to_string(numRows) + " " + to_string(numCols) + " " + to_string(minval) + " " +
to_string(maxval);

	ImageCompression obj(numRows, numCols, minval, maxval);

	obj.loadImage(inFile);

	obj.Compute8Distance(outFile);

	obj.ImageCompresser(outFile, outFile2); outFile2.close(); skfile.open(argv[1] + subname);

	obj.loadskeleton(skfile);

	obj.ImageDeCompression(outFile);

	if (obj.newmaxval != 0) obj.newmaxval = 1;

	outFile3 << numRows << " " << numCols << " " << obj.newminval << " " << obj.newmaxval << "\n";

	obj.threshold(outFile3);

	inFile.close();
	outFile.close();
	skfile.close();
	outFile3.close();
```

```
        return 0;
}
```

ImageCompression:

```
#pragma once
#include <fstream>
# include <iostream>
#include <string>
#include <sstream>
#include <cmath>
#include <algorithm>

class ImageCompression
{
public: int numRows, numCols, imgMin, imgMax, newminval = 0, newmaxval = 0, newmin, newmax;

public: int* histarray;
public: int* gaussarray;
public: int** ZFArray;
public: int** SkeletonArray;

public: ImageCompression(int nr, int nc, int min, int max)
{
	numRows = nr, numCols = nc, imgMax = max, imgMin = min;



	ZFArray = new int* [numRows + 2];
	SkeletonArray = new int* [numRows + 2];

	for (int i = 0; i < numRows + 2; i++)
	{
		ZFArray[i] = new int[numCols + 2];
		//ZFArray[i] = 0;
		SkeletonArray[i] = new int[numCols + 2];
	}

	setZero(ZFArray); setZero(SkeletonArray);
}

public:void setZero(int** ary)
{
	for (int i = 0; i < numRows + 2; i++)
	{
		for (int j = 0; j < numCols + 2; j++)
		{
			ary[i][j] = 0;
		}
	}
}

public: void loadImage(std::ifstream& inFile)
{

	for (int i = 1; i < numRows + 1; i++)
	{
		for (int j = 1; j < numCols + 1; j++)
		{
```

```
                    std::string st;


                    inFile >> st;

                    std::stringstream str(st);



                    str >> ZFArray[i][j];
            }
        }
}

public: void Compute8Distance(std::ofstream& outfile)
{

        firstPass8Distance();

        reformatPrettyPrint(ZFArray, outfile, "Result of Pass 1:\n\n\n");

        secondPass8Distance();

        reformatPrettyPrint(ZFArray, outfile, "Result of Pass 2:\n\n\n");
}

public: void firstPass8Distance()
{
        for (int i = 1; i < numRows + 1; i++)
        {
                for (int j = 1; j < numCols + 1; j++)
                {
                        if (ZFArray[i][j] > 0)
                        {
                                int min1 = std::min(ZFArray[i-1][j-1], ZFArray[i-1][j]), min2 = std::min(ZFArray[i
1][j+1], ZFArray[i][j-1]);

                                ZFArray[i][j] = std::min(min1, min2) + 1;

                        }
                }
        }
}

public: void secondPass8Distance()
{
        for (int i = numRows; i > 0; i--)
        {
                for (int j = numCols; j > 0; j--)
                {
                        if (ZFArray[i][j] > 0)
                        {
                                int min1 = std::min(ZFArray[i][j + 1], ZFArray[i + 1][j - 1]),
                                        min2 = std::min(ZFArray[i + 1][j], ZFArray[i + 1][j + 1]),
                                        min3 = std::min(min1, min2) + 1;
```

```
                        ZFArray[i][j] = std::min(ZFArray[i][j], min3);

                    }
                }
        }
}

public: void reformatPrettyPrint(int** ary, std::ofstream& outfile, std::string
caption) {
        outfile << caption+"\n";

        for (int i = 1; i < numRows + 1; i++)
        {
                for (int j = 1; j < numCols + 1; j++)
                {
                        if (ary[i][j] > 0) { outfile << ary[i][j]<<" "; }
                        else { outfile << "0 "; }
                }
                outfile << "\n";
        }

        outfile << "-----------------------------------------------\n\n";

}

public: void ImageCompresser(std::ofstream& outfile, std::ofstream& skeletonfile)
{
        calLocalMaxima();
        reformatPrettyPrint(SkeletonArray, outfile, "Skeleton Image");
        extractSkeleton(skeletonfile);

}

public: void calLocalMaxima()
{
        for (int i = 1; i < numRows + 1; i++)
        {
                for (int j = 1; j < numCols + 1; j++)
                {
                        int val = ZFArray[i][j];
                        if (val > 0)
                        {
                                if (val >= ZFArray[i - 1][j - 1] && val >= ZFArray[i - 1][j] && val >= ZFArray[i -
1][j + 1] && val >= ZFArray[i][j - 1] &&
                                        val >= ZFArray[i][j + 1] && val >= ZFArray[i + 1][j - 1] && val >= ZFArray[i
+ 1][j] && val >= ZFArray[i + 1][j + 1])
                                {

                                        SkeletonArray[i][j] = val;

                                        if (val > newmaxval)
                                                newmaxval = val;

                                }
                        }
                }
        }
```

```
}

public: void extractSkeleton(std::ofstream& outfile)
{

	outfile << numRows << " " << numCols << " " << newminval << " " << newmaxval << "\n";
	for (int i = 1; i < numRows + 1; i++)
	{
		for (int j = 1; j < numCols + 1; j++)
		{
			if (SkeletonArray[i][j] > 0)
			{
				outfile << i << " " << j << " " << SkeletonArray[i][j] << "\n";

			}
		}
	}
}

public: void loadskeleton(std::ifstream& skfile)
{
	setZero(ZFArray);

	std::string header;
	getline(skfile, header);
	while (!skfile.eof())
	{
		int row = 0, col = 0, val = 0;
		skfile >> row; skfile >> col; skfile >> val;

		ZFArray[row][col] = val;
	}
}

public: void ImageDeCompression(std::ofstream& outfile)
{
	firstpassExpansion();
	reformatPrettyPrint(ZFArray, outfile, "Result of 1st Pass Expansion");

	secondPassExpansion();
	reformatPrettyPrint(ZFArray, outfile, "Result of 2nd Pass Expansion");

}

public: void firstpassExpansion()
{
	for (int i = 1; i < numRows + 1; i++)
	{
		for (int j = 1; j < numCols + 1; j++)
		{

			if (ZFArray[i][j] == 0 && (ZFArray[i - 1][j - 1] > 1 || ZFArray[i - 1][j] > 1 || ZFArray[i
- 1][j + 1] > 1
				|| ZFArray[i][j - 1] > 1 || ZFArray[i][j + 1] > 1 || ZFArray[i + 1][j - 1] > 1 ||
			ZFArray[i + 1][j] > 1 || ZFArray[i + 1][j + 1] > 1))
			{
				int max1 = std::max(ZFArray[i - 1][j - 1], ZFArray[i - 1][j]), max2 =
```

```
std::max(ZFArray[i - 1][j + 1], ZFArray[i][j - 1]),
                                    max3 = std::max(ZFArray[i][j + 1], ZFArray[i + 1][j - 1]), max4 =
std::max(ZFArray[i + 1][j], ZFArray[i + 1][j + 1]);
                             int fmax1 = std::max(max1, max2), fmax2 = std::max(max3, max4);
                             ZFArray[i][j] = std::max(fmax1, fmax2) - 1;
                      }
               }
       }
}

public: void secondPassExpansion()
{
       for (int i = numRows; i > 0; i--)
       {
              for (int j = numCols; j > 0; j--)
              {
                     if (ZFArray[i - 1][j - 1] > 1 || ZFArray[i - 1][j] > 1 || ZFArray[i - 1][j + 1] > 1 ||
                            ZFArray[i][j - 1] > 1 || ZFArray[i][j + 1] > 1 || ZFArray[i + 1][j - 1] > 1 ||
                             ZFArray[i + 1][j] > 1 || ZFArray[i + 1][j + 1] > 1)
                     {
                             int max1 = std::max(ZFArray[i - 1][j - 1], ZFArray[i - 1][j]), max2 =
std::max(ZFArray[i - 1][j + 1], ZFArray[i][j - 1]),
                                    max3 = std::max(ZFArray[i][j + 1], ZFArray[i + 1][j - 1]), max4 =
std::max(ZFArray[i + 1][j], ZFArray[i + 1][j + 1]);
                             int fmax1 = std::max(max1, max2), fmax2 = std::max(max3, max4);

                             if(ZFArray[i][j] < (std::max(fmax1, fmax2) - 1))
                             ZFArray[i][j] = std::max(fmax1, fmax2) - 1;
                      }
              }
       }
}

public: void threshold(std::ofstream& decomp)
{
       for (int i = 1; i < numRows + 1; i++)
       {
              for (int j = 1; j < numCols + 1; j++)
              {

                     if (ZFArray[i][j] >= 1)
                            decomp << "1 ";
                     else decomp << "0 ";
              }
              decomp << "\n";
       }
}

public:void showArray(int** ary, int nr, int nc)
        {
               for (int i = 1; i < nr + 1; i++)
               {
                      for (int j = 1; j < nc + 1; j++)
                      {
                             std::cout << ary[i][j] << " ";
                      }
                      std::cout << std::endl;
```

```
            }
            std::cout << "\n\n\n";
        }


};
```

Image1:

InputFile:

```
20 22 0 1
0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0
0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0
0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0
0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0
0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0
0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0
0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0
```

OutputFile1:

Result of Pass 1:

```
0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 1 2 2 2 2 2 1 1 0 0 0 0 0 0 0 0
0 0 0 0 0 1 1 2 2 3 3 3 2 2 1 1 0 0 0 0 0 0 0 0
0 0 0 0 1 1 2 2 3 3 4 3 3 2 2 1 1 0 0 0 0 0 0 0
0 0 0 0 1 2 2 3 3 4 4 4 3 3 2 2 1 0 0 0 0 0 0 0
0 0 0 1 1 2 3 3 4 4 5 4 4 3 3 2 1 1 0 0 0 0 0 0
1 1 1 1 1 2 2 3 4 4 5 5 5 4 4 3 2 2 1 1 1 1 1 1
0 0 0 1 2 3 3 4 5 5 6 5 5 4 3 3 2 2 0 0 0 0 0 0
0 0 0 0 1 2 3 4 5 6 6 6 5 4 4 3 3 0 0 0 0 0 0 0
0 0 0 0 1 2 3 4 5 6 7 6 5 5 4 4 1 0 0 0 0 0 0 0
0 0 0 0 0 1 2 3 4 5 6 6 6 5 5 2 0 0 0 0 0 0 0 0
0 0 0 0 0 1 2 3 4 5 6 6 6 3 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 1 2 3 4 5 6 4 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 2 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 2 1 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 2 1 0 0 0 0 0 0 0 0 0 0 0 0 0
```

Result of Pass 2:

```
0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 1 2 2 2 2 2 1 1 0 0 0 0 0 0 0 0
0 0 0 0 0 1 1 2 2 3 3 3 2 2 1 1 0 0 0 0 0 0 0 0
0 0 0 0 1 1 2 2 3 3 4 3 3 2 2 1 1 0 0 0 0 0 0 0
0 0 0 0 1 2 2 3 3 4 4 4 3 3 2 2 1 0 0 0 0 0 0 0
0 0 0 1 1 2 3 3 4 4 5 4 4 3 3 2 1 1 0 0 0 0 0 0
1 1 1 1 1 2 2 3 4 4 5 5 5 4 4 3 2 2 1 1 1 1 1 1
0 0 0 1 1 2 3 3 4 4 5 4 4 3 3 2 1 1 0 0 0 0 0 0
0 0 0 0 1 2 2 3 3 4 4 4 3 3 2 2 1 0 0 0 0 0 0 0
0 0 0 0 1 1 2 2 3 3 4 3 3 2 2 1 1 0 0 0 0 0 0 0
0 0 0 0 0 1 1 2 2 3 3 4 3 3 2 1 1 0 0 0 0 0 0 0
```

0 0 0 0 0 0 0 1 1 2 2 2 2 2 1 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 1 1 2 1 1 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 2 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 2 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0

Skeleton Image

0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 4 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 5 0 0 0 0 0 0 0 0 0 0
1 1 1 1 0 2 0 0 4 0 5 5 5 0 4 0 0 2 0 1 1 1
0 0 0 0 0 0 0 0 0 0 0 5 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 4 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

Result of 1st Pass Expansion

0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 3 3 3 2 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 2 3 4 3 2 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 2 4 4 4 3 2 1 0 0 0 0 0 0 0
0 0 0 0 1 1 1 3 3 4 4 5 4 4 3 3 2 1 1 0 0 0
1 1 1 1 1 2 2 3 4 4 5 5 5 4 4 3 3 2 2 1 1 1 1
0 0 0 0 1 1 2 3 3 4 4 5 4 4 3 3 2 1 1 0 0 0
0 0 0 0 1 2 2 3 3 4 4 4 3 3 2 2 1 0 0 0 0 0
0 0 0 0 1 1 2 2 3 3 4 3 3 2 2 1 1 0 0 0 0 0
0 0 0 0 0 1 1 2 2 3 3 3 3 2 2 1 1 0 0 0 0 0
0 0 0 0 0 0 1 1 2 2 2 2 2 1 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 1 1 2 1 1 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 2 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 2 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0

Result of 2nd Pass Expansion

0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 1 1 2 2 2 2 2 1 1 0 0 0 0 0 0 0
0 0 0 0 0 1 1 2 2 3 3 3 2 2 1 1 0 0 0 0 0 0
0 0 0 0 1 1 2 2 3 3 4 3 3 2 2 1 1 0 0 0 0 0
0 0 0 0 1 2 2 3 3 4 4 4 3 3 2 2 1 0 0 0 0 0
0 0 0 1 1 2 3 3 4 4 5 4 4 3 3 2 1 1 0 0 0 0
1 1 1 1 1 2 2 3 4 4 5 5 5 4 4 3 3 2 2 1 1 1 1
0 0 0 1 1 2 3 3 4 4 5 4 4 3 3 2 1 1 0 0 0 0
0 0 0 0 1 2 2 3 3 4 4 4 3 3 2 2 1 0 0 0 0 0
0 0 0 0 1 1 2 2 3 3 4 3 3 2 2 1 1 0 0 0 0 0
0 0 0 0 0 1 1 2 2 3 3 3 3 2 2 1 1 0 0 0 0 0
0 0 0 0 0 0 1 1 2 2 2 2 2 1 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 1 1 2 1 1 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 2 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 2 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0

SkeletonFile:

20 22 0 5
1 12 1
2 12 1
3 12 1
4 12 1
8 12 4
10 12 5
11 1 1
11 2 1

11 3 1
11 4 1
11 6 2
11 9 4
11 11 5
11 12 5
11 13 5
11 15 4
11 18 2
11 20 1
11 21 1
11 22 1
12 12 5
14 12 4
17 12 2
18 12 2
19 12 2

DecompressFile

: 20 22 0 1
0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0
0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0

Image2:

InputFile:

50 64 0 1
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
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OutputFile1:

Result of Pass 1:

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Result of Pass 2:

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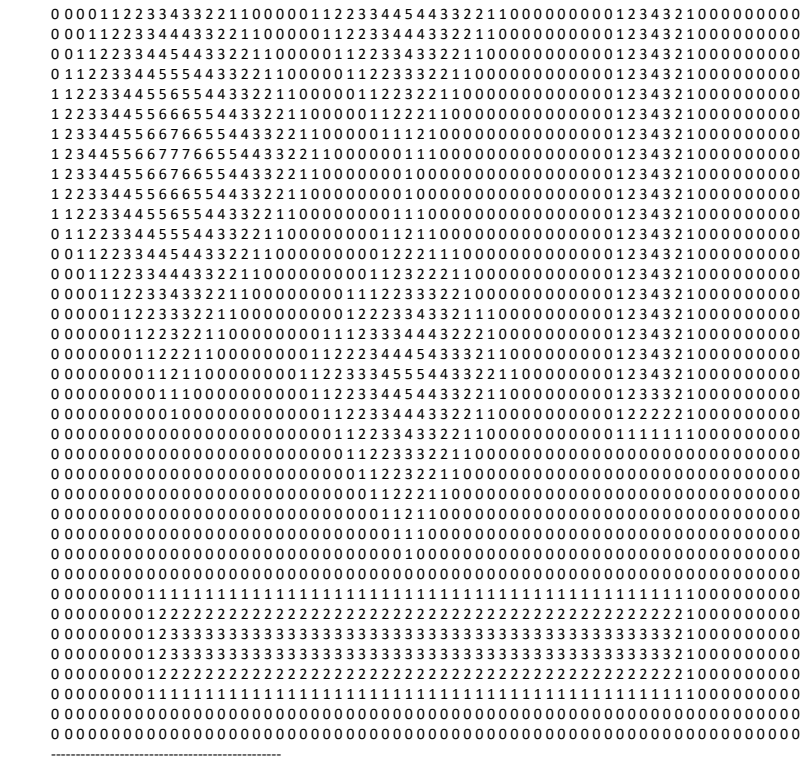
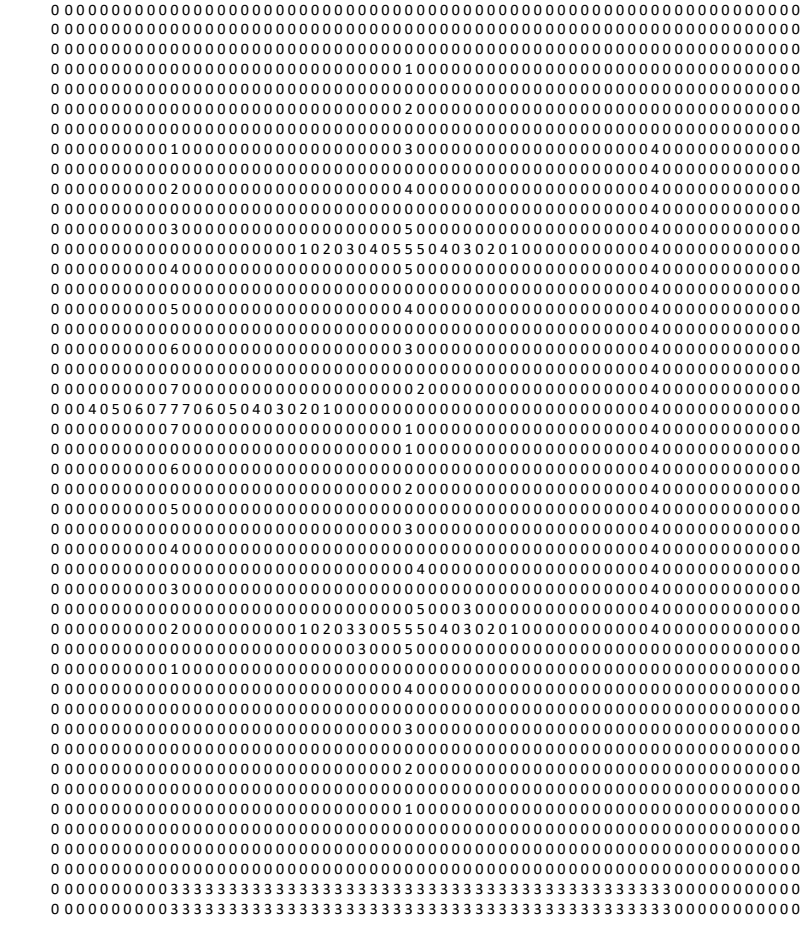
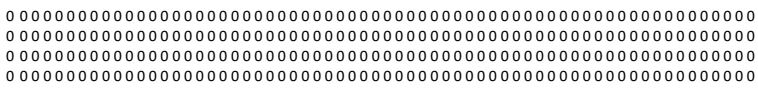
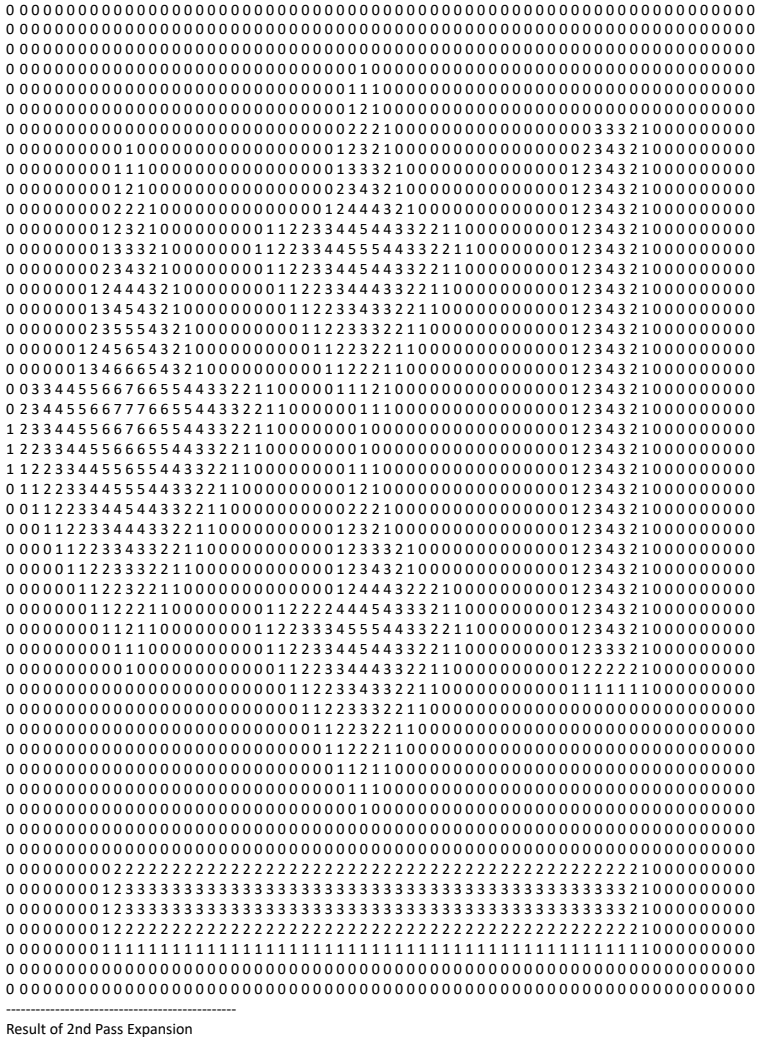


Skeleton Image

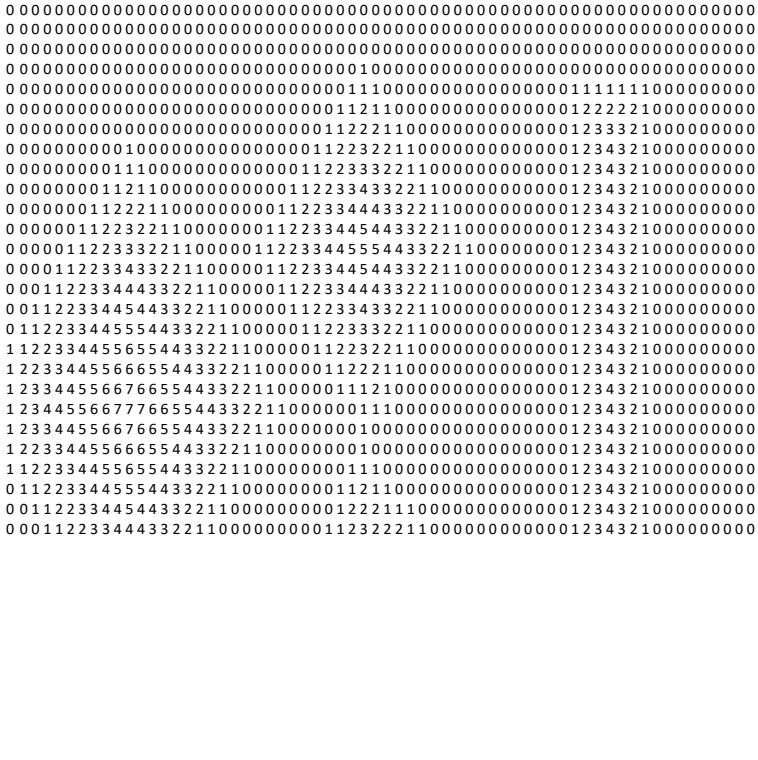




Result of 1st Pass Expansion



Result of 2nd Pass Expansion



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13 28 4
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21 20 3
21 22 2
21 24 1
21 52 4
22 11 7

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DecompressFile:

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