TeamProject

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Contents

1 CPPaddHeaderData.cpp

```
/*******************************************************************
* File:  CPPaddHeaderData.cpp
* Author(s):  Natalie Peck, Gurpreet Singh, Justin Anaya, Sheharyar Khan
* Class:  CS-124-02
* Term:  Spring 2019
* Lab:  Team Project
* Date:  17 May 2019
* Despcription:
Using a median filter, this program filters out something blocking
the desired focal point of a series of photos.
*******************************************************************/

**System Libraries **
#include <fstream>
#include <iostream>
#include <vector>

**User Libraries **
#include "Hlab.h"
#include "HmaxHeap.h"
#include "HminHeap.h"

**namespace declaration **
using namespace std;
```

```
****************************************
*****addHeaderData() Function Definition *****
****************************************

void addHeaderData(string header[], ofstream& newImage)
{
        for(int i = 0; i < 3; i++)
        {
                newImage.write(header[i].c_str(), header[i].length());
                newImage << "\n";
        }
}
```

2 CPPcheckBalance.cpp

```
/*****************************************************************
* File:  CPPcheckBalance.cpp
* Author(s):  Natalie Peck, Gurpreet Singh, Justin Anaya, Sheharyar Khan
* Class:  CS-124-02
* Term:  Spring 2019
* Lab:  Team Project
* Date:  17 May 2019
* Despcription:
The definition of the function that checks the size of the min heap
and max heap and calls the function to rebalance them if the
difference is greater than 1 or less than -1.
*****************************************************************/

**System Libraries **
#include <fstream>
#include <iostream>
#include <vector>

**User Libraries **
#include "Hlab.h"
#include "HmaxHeap.h"
#include "HminHeap.h"

**namespace declaration **
using namespace std;
```

```
****************************************
*****checkBalance() Function Definition *****
****************************************

void checkBalance(MinHeap<int>& minHeap, MaxHeap<int>& maxHeap)
{
        int check = minHeap.size() - maxHeap.size();

         cout << endl << "check is:  " << check << endl;

        if (check > 1 || check < (-1))
        {
                 cout << "before heapRebalance is called" << endl;cout << "size of
                    minHeap:  " << minHeap.size() << endl;cout << "size of maxHeap:  "
                    << maxHeap.size() << endl;
                heapRebalance(minHeap, maxHeap);
                 cout << "heapRebalance called" << endl;cout << "size of minHeap:  " <<
                    minHeap.size() << endl;cout << "size of maxHeap:  " <<
                    maxHeap.size() << endl;
        }

        else
        {
                return;
        }
}
```

3 CPPemptyHeaps.cpp

```
/*******************************************************************
* File:  CPPemptyHeaps.cpp
* Author(s):  Natalie Peck, Gurpreet Singh, Justin Anaya, Sheharyar Khan
* Class:  CS-124-02
* Term:  Spring 2019
* Lab:  Team Project
* Date:  17 May 2019
* Despcription:
The definitions of the functions that empty the max or min heap by
popping all values in the heap.
*******************************************************************/

**System Libraries **
#include <fstream>
#include <iostream>
#include <vector>

**User Libraries **
#include "Hlab.h"
#include "HmaxHeap.h"
#include "HminHeap.h"

**namespace declaration **
using namespace std;
```

```
****************************************
*****emptyMinHeap() Function Definition *****
****************************************

void emptyMinHeap(MinHeap<int>& minHeap)
{
          pop all values in minHeap
         for(int b = 0; b < minHeap.size(); b++)
         {
                  minHeap.pop();
         }
}

****************************************
*****emptyMaxHeap() Function Definition *****
****************************************

void emptyMaxHeap(MaxHeap<int>& maxHeap)
{
          pop all values in maxHeap
         for(int b = 0; b < maxHeap.size(); b++)
         {
                  maxHeap.pop();
         }
}
```

4 CPPfillHeaps.cpp

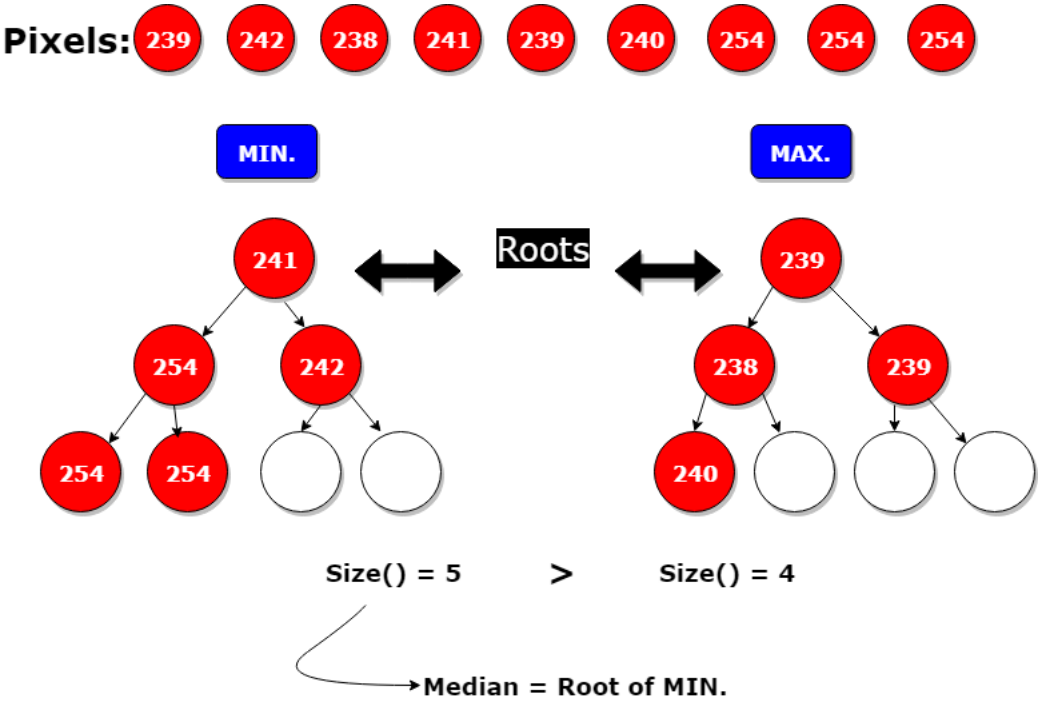
```
/*******************************************************************
* File:  CPPfillHeaps.cpp
* Author(s):  Natalie Peck, Gurpreet Singh, Justin Anaya, Sheharyar Khan
* Class:  CS-124-02
* Term:  Spring 2019
* Lab:  Team Project
* Date:  17 May 2019
* Despcription:
The definition of the function where the heaps are filled and then
calls the function to check if they need to be rebalanced.
*******************************************************************/

**System Libraries **
#include <fstream>
#include <iostream>
#include <vector>

**User Libraries **
#include "Hlab.h"
#include "HmaxHeap.h"
#include "HminHeap.h"

**namespace declaration **
using namespace std;
```

```
****************************************
*****fillHeaps() Function Definition *****
****************************************

void fillHeaps(int a, MinHeap<int>& minHeap, MaxHeap<int>& maxHeap, vector<
    vector<int>>& pixelHolder)
{
         compare the current value of the first two files
        if(pixelHolder[0][a] > pixelHolder[1][a])
        {
                minHeap.push(pixelHolder[0][a]);

                maxHeap.push(pixelHolder[1][a]);
        }

        else if(pixelHolder[0][a] < pixelHolder[1][a])
        {
                maxHeap.push(pixelHolder[0][a]);

                minHeap.push(pixelHolder[1][a]);
        }
```

```
        iterate through rest of files
        for(int i = 2; i < pixelHolder.size(); i++)
        {
                if(pixelHolder[i][a] < minHeap.top())
                {
                        maxHeap.push(pixelHolder[i][a]);
                        checkBalance(minHeap, maxHeap);
                }

                else if(pixelHolder[i][a] > minHeap.top())
                {
                        minHeap.push(pixelHolder[i][a]);
                        checkBalance(minHeap, maxHeap);
                }
        }

        cout << "fillHeaps:  after filling the heaps:  " << endl;cout << "size of
           minHeap:  " << minHeap.size() << endl;cout << "size of maxHeap:  " <<
           maxHeap.size() << endl;
}
```

5 CPPgetMedian.cpp

```
*************************************************************************
* File:  CPPgetMedian.cpp
* Author(s):  Natalie Peck, Gurpreet Singh, Justin Anaya, Sheharyar Khan
* Class:  CS-124-02
* Term:  Spring 2019
* Lab:  Team Project
* Date:  17 May 2019
* Despcription:
The definition of the function that finds and print the median from
the roots of the min and max heaps.
If the min heap is larger, the root of the min heap is the median.
If the max heap is larger, the root of the max heap is the median.
If the heaps are of equal size, the average of the roots is the median.
*************************************************************************
```




```
**System Libraries **
#include <fstream>
#include <iostream>
#include <vector>

**User Libraries **
#include "Hlab.h"
```

```
#include "HmaxHeap.h"
#include "HminHeap.h"

**namespace declaration **
using namespace std;
```

```
****************************************
*****getMedian() Function Definition *****
****************************************

void getMedian(ofstream& newImage, MinHeap<int>& minHeap, MaxHeap<int>&
    maxHeap, int count)
{
          cout << "getMedian:  before size comparisons and median prints:  " << endl;cout
             << "size of minHeap:  " << minHeap.size() << endl;cout << "size of maxHeap:
             " << maxHeap.size() << endl;

         if(minHeap.size() > maxHeap.size())  if minHeap is larger
         {
                   cout << "MinHeap.top:  " << minHeap.top() << endl;
                  newImage << minHeap.top();
         }

         else if(minHeap.size() < maxHeap.size())  if maxHeap is larger
         {
                   cout << "MaxHeap.top:  " << maxHeap.top() << endl;
                  newImage << maxHeap.top();
         }

         else  if the heaps are equal size
         {
                  int tmp = (maxHeap.top() + minHeap.top()) / 2;
                   cout << "Median is:  " << tmp << endl;
                  newImage << tmp;
         }
```

```
        if(count%3 == 0)
        {
                newImage << "\n";
        }

        else
        {
                newImage << " ";
        }
}
```

6 CPPheapRebalance.cpp

```
*********************************************************************
* File:  CPPheapRebalance.cpp
* Author(s):  Natalie Peck, Gurpreet Singh, Justin Anaya, Sheharyar Khan
* Class:  CS-124-02
* Term:  Spring 2019
* Lab:  Team Project
* Date:  17 May 2019
* Despcription:
The definition of the function that rebalances the min and max heap
when the size of one is greater than the other by two or more values.
This is accomplished by removing and storing the root value of the
larger heap, reHeaping the reduced heap to maintain the desired
priority order and then pushing the stored value to the other heap.
*********************************************************************

**System Libraries **
#include <fstream>
#include <iostream>
#include <vector>

**User Libraries **
#include "Hlab.h"
#include "HmaxHeap.h"
#include "HminHeap.h"

**namespace declaration **
using namespace std;
```

```
*****************************************
*****heapRebalance() Function Definition *****
*****************************************

void heapRebalance(MinHeap<int>& minHeap, MaxHeap<int>& maxHeap)
{
        if(minHeap.size() > maxHeap.size())  if minHeap is larger
        {
                 cout << "more min" << endl;

                minHeap.fix_heap_public();

                 cout << "heapRebalance:  after fixHeap:  " << endl;cout << "size of
                    minHeap:  " << minHeap.size() << endl;

                int temp = minHeap.top();

                 cout << "temp value:  " << temp << endl;

                minHeap.pop();

                 cout << "heapRebalance:  after minHeap.pop():  " << endl;cout << "size
                    of minHeap:  " << minHeap.size() << endl;cout << "size of maxHeap:
                    " << maxHeap.size() << endl;
```

```
            maxHeap.push(temp);

             cout << "heapRebalance:  after maxHeap.push(temp):  " << endl;cout <<
                "size of minHeap:  " << minHeap.size() << endl;cout << "size of
                maxHeap:  " << maxHeap.size() << endl;cout << "MinHeap" <<
                endl;minHeap.printHeapPublic();cout << "MaxHeap" <<
                endl;maxHeap.printHeapPublic();
}
```

```
else if(minHeap.size() < maxHeap.size())  if maxHeap is larger
{
          cout << "more max" << endl;

         maxHeap.fix_heap_public();

          cout << "heapRebalance:  after fixHeap:  " << endl;cout << "size of
             maxHeap:  " << maxHeap.size() << endl;

         int temp = maxHeap.top();

          cout << "temp value:  " << temp << endl;

         maxHeap.pop();

          cout << "heapRebalance:  after maxHeap.pop():  " << endl;cout << "size
             of minHeap:  " << minHeap.size() << endl;cout << "size of maxHeap:
             " << maxHeap.size() << endl;
```

```
                minHeap.push(temp);

                 cout << "heapRebalance:  after minHeap.push(temp):  " << endl;cout <<
                    "size of minHeap:  " << minHeap.size() << endl;cout << "size of
                    maxHeap:  " << maxHeap.size() << endl;cout << "MinHeap" <<
                    endl;minHeap.printHeapPublic();cout << "MaxHeap" <<
                    endl;maxHeap.printHeapPublic();
        }

        else  if heaps are equal
        {
                 cout << "Heaps are equal" << endl;
        }
}
```

7 CPPheapStuff.cpp

```
/*****************************************************************
* File:  CPPheapStuff.cpp
* Author(s):  Natalie Peck, Gurpreet Singh, Justin Anaya, Sheharyar Khan
* Class:  CS-124-02
* Term:  Spring 2019
* Lab:  Team Project
* Date:  17 May 2019
* Despcription:
The definition of the function that calls functions to create and fill
the min and max heaps, find, retrieve and print the median values, and
reset the heaps.
*****************************************************************/

**System Libraries **
#include <fstream>
#include <iostream>
#include <vector>

**User Libraries **
#include "Hlab.h"
#include "HmaxHeap.h"
#include "HminHeap.h"

**namespace declaration **
using namespace std;
```

```
****************************************
*****heapStuff() Function Definition *****
****************************************

void heapStuff(ofstream& newImage, MinHeap<int>& minHeap, MaxHeap<int>&
    maxHeap, vector<vector<int>>& pixelHolder)
{
        MinHeap<int> minHeapTemp = minHeap;
        MaxHeap<int> maxHeapTemp = maxHeap;
        int count = 1;

        for(int a = 0; a < pixelHolder[0].size(); a++)
        { iterate through all lines/vector values

                ********Heaps filled *********
                fillHeaps(a, minHeapTemp, maxHeapTemp, pixelHolder);

                 cout << "avoided segv 01" << endl;

                *******Median Obtained *******
                 cout << "heapStuff:  before getMedian:  " << endl;cout << "size of
                    minHeap:  " << minHeapTemp.size() << endl;cout << "size of maxHeap:
                    " << maxHeapTemp.size() << endl;
                if(minHeapTemp.size() != 0 && maxHeapTemp.size() != 0)
                {
                        getMedian(newImage, minHeapTemp, maxHeapTemp, count)
                            ;

                        count++;
                }

                 cout << "avoided segv 02" << endl;
```

```
                    *******Heaps emptied *******
                    emptyMinHeap(minHeapTemp);

                     cout << "avoided segv 03" << endl;

                    minHeapTemp = minHeap;

                     cout << "avoided segv 04" << endl;

                    emptyMaxHeap(maxHeapTemp);

                     cout << "avoided segv 05" << endl;

                    maxHeapTemp = maxHeap;

                     cout << "avoided segv 06" << endl;
            }

             cout << "avoided segv 07" << endl;
}
```

8 CPPmain.cpp

```
/*******************************************************************
* File:  CPPmain.cpp
* Author(s):  Natalie Peck, Gurpreet Singh, Justin Anaya, Sheharyar Khan
* Class:  CS-124-02
* Term:  Spring 2019
* Lab:  Team Project
* Date:  17 May 2019
* Despcription:
Using a median filter, this program filters out something blocking
the desired focal point of a series of photos.
*******************************************************************/

Compilation Command:g++ -g -I/home/debian -o lab CPP*.cpp -I/home/debian/fltk-1.3.4-2
    `fltk-config --cxxflags --ldflags --use-images --use-cairo`

**System Libraries **
#include <fstream>
#include <iostream>
#include <string>
#include <vector>

**User Libraries **
#include "Hlab.h"
#include "HmaxHeap.h"
#include "HminHeap.h"
```

```
**FLTK Libraries**
#include "config.h"
#include "FL/Fl_Cairo_Window.H"
#include "FL/Fl_Button.H"
#include "FL/Fl_Value_Input.H"
#include "FL/Fl_Text_Display.H"
#include <FL/Fl_Input.H>
#include <FL/Fl_PNG_Image.H>
#include <FL/Fl_Box.H>

**Namespace Declaration **
using namespace std;

**Global Variable(s) **
vector<vector<int>> pixelHolder;
string file_list;

*FLTK Global Variables **
const int WIDTH = 600;
const int HEIGHT = 600;
Fl_Input* prefix = nullptr;
Fl_Button* submit = nullptr;
Fl_Button* findBut = nullptr;
Fl_Button* clearBut = nullptr;
Fl_Button* showBut = nullptr;
Fl_Text_Display* files = nullptr;
Fl_Text_Buffer* buff = nullptr;
Fl_Cairo_Window* cw = nullptr;
Fl_PNG_Image* png = nullptr;
Fl_Box* imgBox = nullptr;
```

```
*Global Pointers (for use in FLTK callbacks) *
ofstream *newImagePointer;
MinHeap<int>* minHeapPointer;
MaxHeap<int>* maxHeapPointer;

*FLTK Callback declarations *
void submitCB(void*, void*);
void findCB(void*, void*);
void showCB(void*, void*);
void clearCB(void*, void*);

**********************
*****Main Progam *****
**********************

int main()
{
        ofstream debug; debug.open("debug.txt");

         cout << "avoided segv A" << endl;

        ofstream newImage;

         cout << "avoided segv B" << endl;

        newImage.open("output.ppm");

         cout << "avoided segv C" << endl;

        MinHeap<int> minHeap;

         cout << "avoided segv D" << endl;
```

```
MaxHeap<int> maxHeap;

 cout << "avoided segv E" << endl;

newImagePointer = &newImage;
minHeapPointer = &minHeap;
maxHeapPointer = &maxHeap;

readFiles(newImage, pixelHolder, debug);/*cout << "avoided segv F" <<
    endl;/*for(int i = 0; i < pixelHolder.size(); i++)cout << "There are " <<
    pixelHolder[i].size() << " pixels in each picture" << endl;
 cout << "avoided segv G" << endl;heapStuff(newImage, minHeap, maxHeap,
    pixelHolder);

cw = new Fl_Cairo_Window(WIDTH,HEIGHT);

int w, h, x, y;

w = WIDTH * 0.3;
h = HEIGHT * 0.1;
x = WIDTH * 0.6;
y = HEIGHT * 0.65;
findBut = new Fl_Button(x, y, w, h, "Find Files");
findBut->callback((Fl_Callback*)findCB);
```

```
w = WIDTH * 0.3;
h = HEIGHT * 0.1;
x = (WIDTH - w) * 0.5;
y = HEIGHT * 0.85;
submit = new Fl_Button(x, y, w, h, "Remove Noise");
submit->callback((Fl_Callback*)submitCB);

w = WIDTH * 0.3;
h = HEIGHT * 0.1;
x = WIDTH * 0.6;
y = HEIGHT * 0.5;
clearBut = new Fl_Button(x, y, w, h, "Clear");
clearBut->callback((Fl_Callback*)clearCB);

w = WIDTH * 0.3;
h = HEIGHT * 0.1;
x = WIDTH * 0.6;
y = HEIGHT * 0.3;
showBut = new Fl_Button(x, y, w, h, "Show");
showBut->callback((Fl_Callback*)showCB);

w = WIDTH * 0.5;
h = HEIGHT * 0.5;
x = WIDTH * 0.1;
y = HEIGHT * 0.1;
files = new Fl_Text_Display(x, y, w, h, "Files Found:");
```

```
        w = WIDTH * 0.3;
        h = HEIGHT * 0.1;
        x = WIDTH * 0.3;
        y = HEIGHT * 0.65;
        prefix = new Fl_Input(x, y, w, h, "File Prefix:");
        buff = new Fl_Text_Buffer;

        files->buffer(*buff);
        cw->show();

    return Fl::run();
}  End of Main

*****************************
**FLTK Callback Definitions **
*****************************

*****************Remove Noise Button's Callback ******************
This is the callback for the remove noise button.  It was previously labeled submit but I
    thought that "remove noise" suited it better.  This function calls the heapStuff
    function.  Th heapStuff function the the backbone of the labe and removes the noise.
void submitCB(void*, void*)
{
        cout << "removing noise" << endl;
        for(int i = 0; i < pixelHolder.size(); i++)
        {
                        cout << "There are " << pixelHolder[i].size() << "
                            pixels in each picture" << endl;
        }
        heapStuff(*newImagePointer, *minHeapPointer, *maxHeapPointer,
            pixelHolder);
        cw->redraw();
```

```
        system("wc -w output.ppm > size.txt");
        ifstream ifs("size.txt");
        int pixels = 0;
        ifs >> pixels;
        cout<<"output file has " << pixels <<" pixels." <<endl;
        cout << "noise removed" << endl;
}
```

**********Find Button's Callback **********
This is the find button callback. It finds the files based on the file prefix. For example if the file prefix is "image" it will finde all the files with that prefix and the .ppm extension.

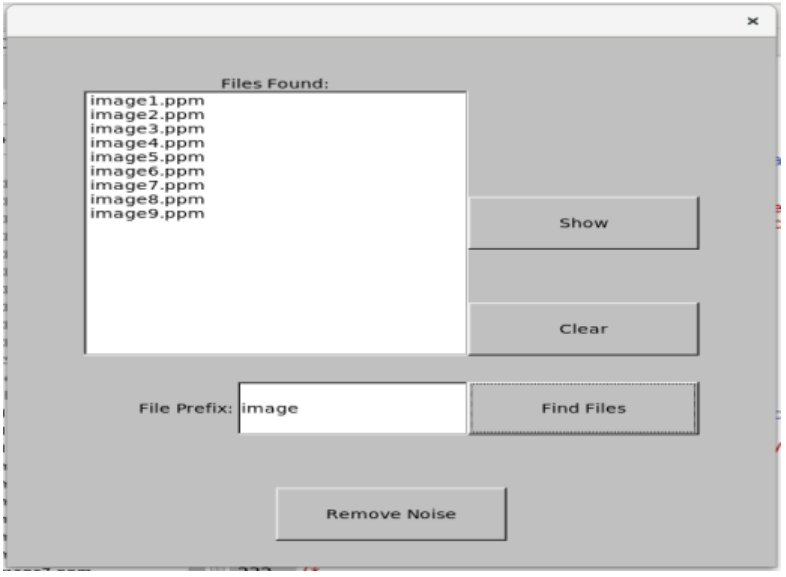

```
void findCB(void*, void*)
{
        cout << "finding" << endl;
        readFiles(*newImagePointer, pixelHolder, file_list, prefix->value())
            ;
        buff->append(file_list.c_str());
        file_list = "";
```

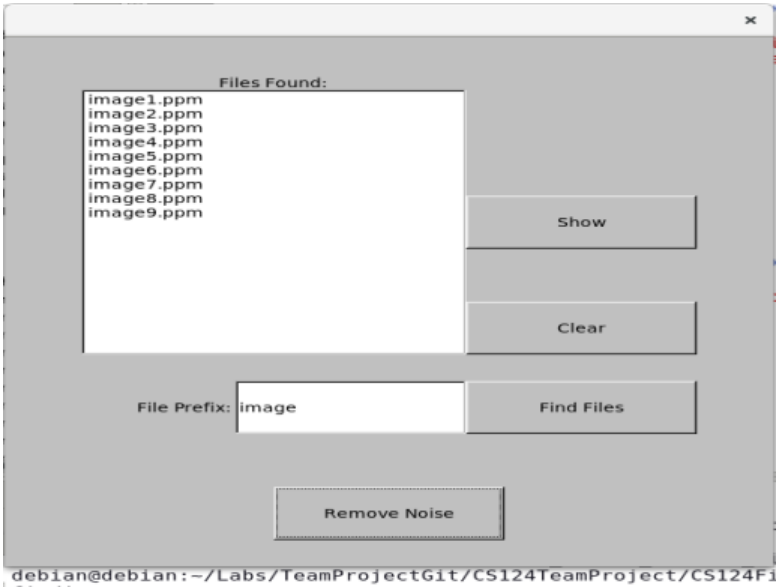
```
            cw->redraw();
            cout << "found" << endl;
}
```

```
******************Clear Button's Callback ******************
This is the clearCB callback.  empties the file list, the vector and the buffer.  First it
    empties the buffer by settting the buffer text to an empty string so that it becomes
    empty.  then it sets the file list to an empty string so that it becomes empty.
    Finally the pixelHolder vector is emptied using the vector::clear() funcction.
void clearCB(void*, void*)
{
        cout << "clearing" << endl;
        buff->text("");
        file_list = "";
        pixelHolder.clear();
        cw->redraw();
        cout << "cleared" << endl;
}
```

```
******************Show Button's Callback ******************
The showCB displays the image using the system command "display" followed by the image
    name.
void showCB(void*, void*)
{
        cout << "displaying" << endl;
        system("display output.ppm");
        cout << "displayed" << endl;
}
```

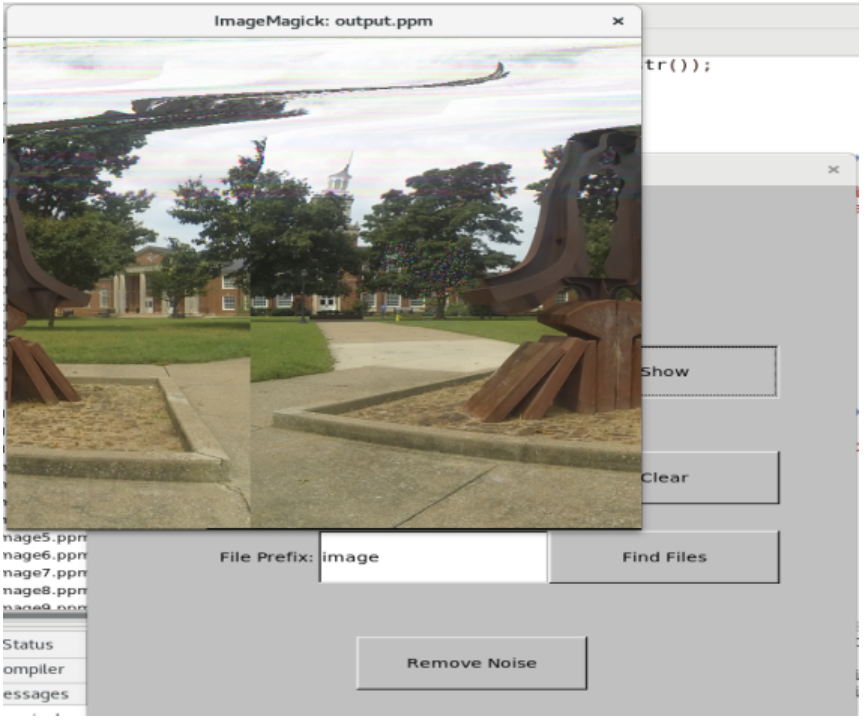
The GUI looks as follows.


Files Found:
image1.ppm
image2.ppm
image3.ppm
image4.ppm
image5.ppm
image6.ppm
image7.ppm
image8.ppm
image9.ppm
Show
Clear
File Prefix:
image
Find Files
Remove Noise




```
debian@debian:~/Labs/TeamProjectGit/CS124TeamProject/CS124Fi
finding
found
removing noise
There are 827145 pixels in each picture
There are 827145 pixels in each picture
There are 827145 pixels in each picture
There are 827145 pixels in each picture
There are 827145 pixels in each picture
There are 827145 pixels in each picture
There are 827145 pixels in each picture
There are 827145 pixels in each picture
There are 827145 pixels in each picture
output file has 824648 pixels.
noise removed
```

As you can see the number of pixels in the output files are are significantly less than the number of pixels in the input files. This means we are losing pixels somewhere. Losing these pixels causes the resulting image to be distorted.



We spent a whole day trying to figure out where these pixels go but we did not succeed in resolving the issue.

9 CPPreadFiles.cpp

```
/*******************************************************************
* File:  CPPreadFiles.cpp
* Author(s):  Natalie Peck, Gurpreet Singh, Justin Anaya, Sheharyar Khan
* Class:  CS-124-02
* Term:  Spring 2019
* Lab:  Team Project
* Date:  17 May 2019
* Despcription:
The definition of the function that locates all image source files
through a system command, pipes the names to another file, reads
those names into a vector and then calls the function to read in
each file's contents to another set of vectors.
*******************************************************************/

**System Libraries **
#include <fstream>
#include <iostream>
#include <string>
#include <vector>

**User Libraries **
#include "Hlab.h"
#include "HmaxHeap.h"
#include "HminHeap.h"

**namespace declaration **
using namespace std;
```

```
*****************************************
*****readFiles() Function Definition *****
*****************************************

//void readFiles(ofstream& newImage, vector<vector<int>>& pixelHolder,
    ofstream& debug)
void readFiles(ofstream& newImage, vector<vector<int>>& pixelHolder, string
    &file_list, string filePrefix)
{
                vector<string> numFiles;  This vector will hold the names of the
                    files
                string line = " ";
                int counter = 0;

                system("ls image*.ppm > file.txt"); // Grabs all PPM images in current
                    directory
                 system("ls test*.ppm > file.txt"); //Grabs all test PPM images in
                    current directory
                string command ="ls "+ filePrefix +"*.ppm > file.txt";
                system(command.c_str());  Grabs all test PPM images in current
                    directory

                ifstream ifs("file.txt");  Opens the newly created text file

                while(getline(ifs, line))  Grabs the file names from text file and
                    pushed it into vector
                {
                        numFiles.push_back(line);
                        file_list += line + "\n";
                        counter++;
                }
```

```
                cout << "There are " << counter << " PPM files " << endl; //Confirms
                    how many PPM Files are in directoryfor(int i = 0; i < counter;
                    i++)cout << numFiles[i] << endl; //Prints out all file namescout <<
                    "There are " << numFiles.size() << " Files" << endl;
                readInFiles(numFiles, newImage, pixelHolder);  Calls to next
                    function
}
```

10 CPPreadInFiles.cpp

```
*********************************************************************
* File:  CPPreadInFiles.cpp
* Author(s):  Natalie Peck, Gurpreet Singh, Justin Anaya, Sheharyar Khan
* Class:  CS-124-02
* Term:  Spring 2019
* Lab:  Team Project
* Date:  17 May 2019
* Despcription:
The definition of a function that opens input streams for all the
source files, reads a line of input from each file, then pushs it to
a vector to store the int values of the pixels for later processing.
*********************************************************************

**System Libraries **
#include <fstream>
#include <iostream>
#include <vector>

**User Libraries **
#include "Hlab.h"
#include "HmaxHeap.h"
#include "HminHeap.h"

**namespace declaration **
using namespace std;
```

```
****************************************
*****readInFiles() Function Definition *****
****************************************
//void readInFiles(vector<string>& fNames, ofstream& newImage, vector<vector
    <int>>& pixelHolder, ofstream& debug)
void readInFiles(vector<string>& fNames, ofstream& newImage, vector<vector<
    int>>& pixelHolder)
{
        string header[3] = {};

        int numbers = 0;

        vector<int> tempFileHolder;  Temp vector which holds all the pixels for one
            image

        for(int i = 0; i < fNames.size(); i++)
        {
                //debug << "File #" << i << endl;

                const char * fileOpen = fNames[i].c_str();

                 cout << "Opening:  " << fileOpen << endl;

                ifstream data(fileOpen);

                for(int j = 0; j < 3; j++)  Grabs the header for each picture so
                    only pixels are left in each picture
                {
                                getline(data,header[j]);
                                 cout << "The header value is:  " << header[j] <<
                                    endl;
                }
```

```
                while(data >> numbers)
                {
                        tempFileHolder.push_back(numbers);
                }

                //debug << "size of temp vector: " << tempFileHolder.size()
                    << endl;

                pixelHolder.push_back(tempFileHolder);

                //debug << "size of pixelHolder: " << pixelHolder.size() <<
                    endl;

                tempFileHolder.clear();
        }

        addHeaderData(header, newImage);
}
```

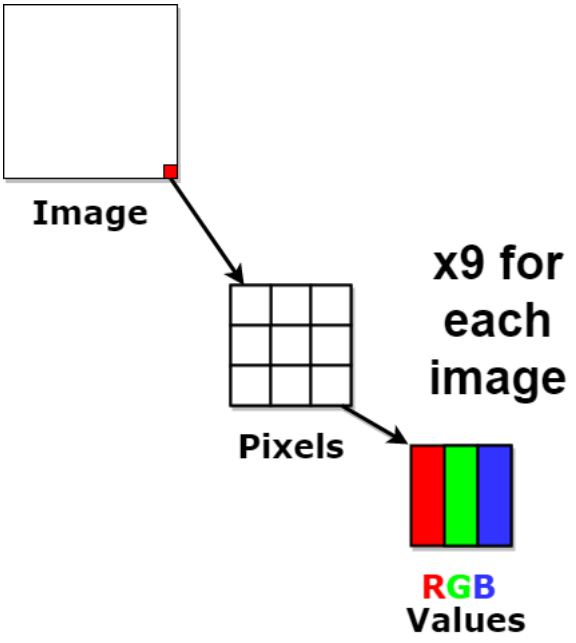
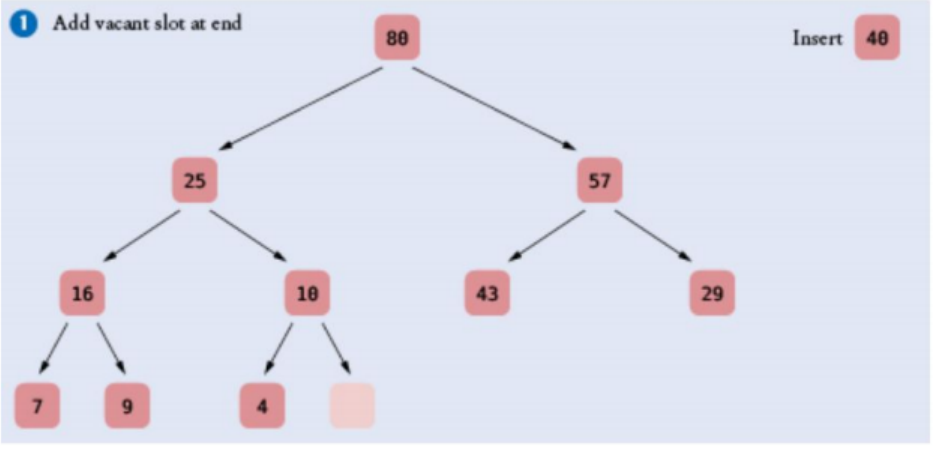


Image
Pixels
x9 for each image
RGB Values

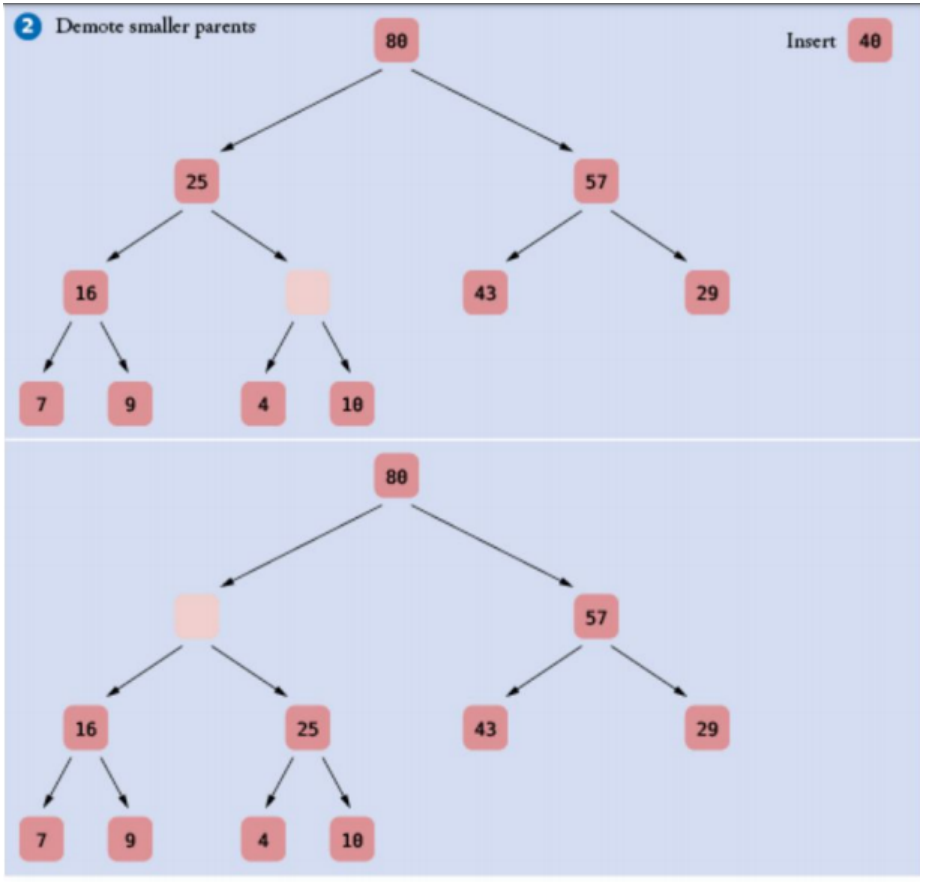
11 Hlab.h

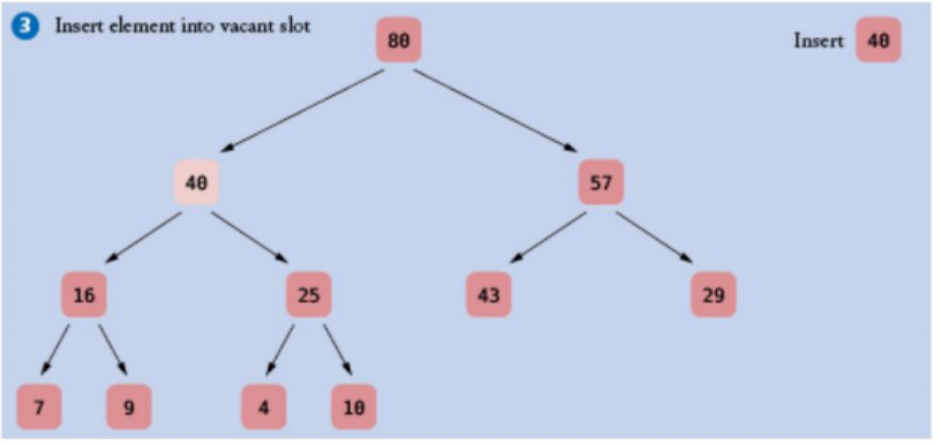
```
**********************************************************************
* File:  Hlab.h
* Author(s):  Natalie Peck, Gurpreet Singh, Justin Anaya, Sheharyar Khan
* Class:  CS-124-02
* Term:  Spring 2019
* Lab:  Team Project
* Date:  17 May 2019
* Despcription:
The class file containing declarations of all the functions needed for
the project.
**********************************************************************

**Duplication Protection **
#ifndef LAB_H
#define LAB_H

**System Libraries **
#include <fstream>
#include <iostream>
#include <vector>

**User Libraries **
#include "HmaxHeap.h"
#include "HminHeap.h"

**Namespace Declaration **
using namespace std;
```

```
**Function Declarations **

void addHeaderData(string[], ofstream&);

//void readInFiles(vector<string>&, ofstream&, vector<vector<int>>&,
    ofstream&);
void readInFiles(vector<string>&, ofstream&, vector<vector<int>>&);

//void readFiles(ofstream&, vector<vector<int>>&, ofstream&);
void readFiles(ofstream&, vector<vector<int>>&, string &file_list, string
    filePrefix);

void heapRebalance(MinHeap<int>&, MaxHeap<int>&);

void checkBalance(MinHeap<int>&, MaxHeap<int>&);

void getMedian(ofstream&, MinHeap<int>&, MaxHeap<int>&, int);

void fillHeaps(int, MinHeap<int>&, MaxHeap<int>&, vector<vector<int>>&);

void emptyMinHeap(MinHeap<int>&);

void emptyMaxHeap(MaxHeap<int>&);

void heapStuff(ofstream&, MinHeap<int>&, MaxHeap<int>&, vector<vector<int
    >>&);

#endif  end of LAB.H
```



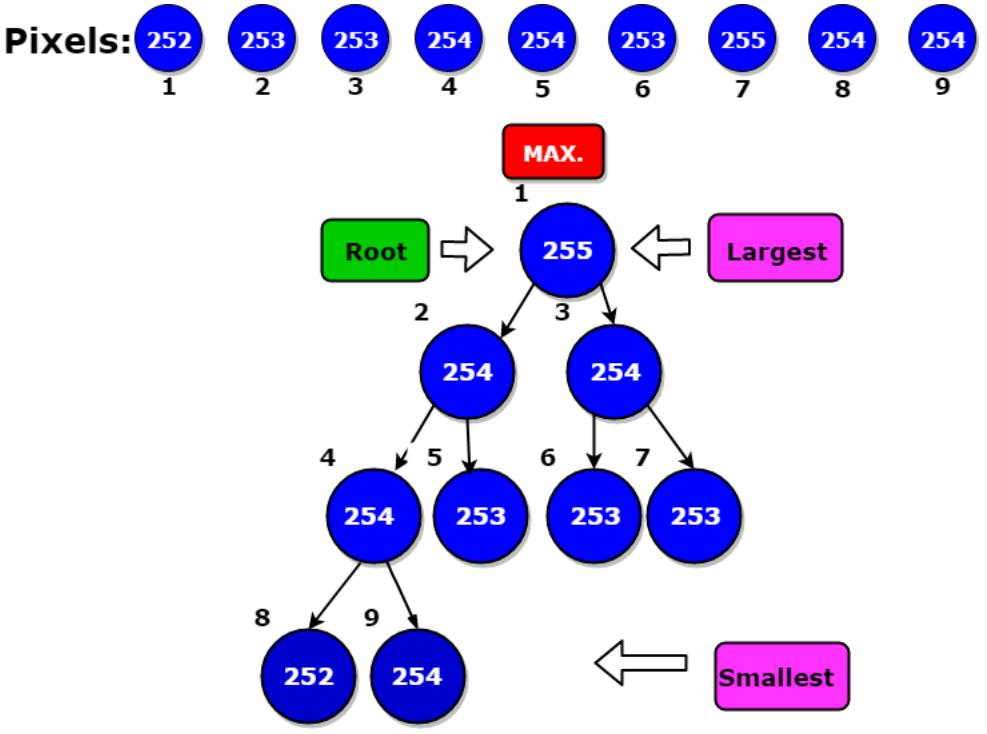
1. First, add a vacant slot to the end of the tree.
2. Next, demote the parent of the empty slot if it is smaller than the element to be inserted. That is, move the parent value into the vacant slot, and move the vacant slot up. Repeat this demotion as long as the parent of the vacant slot is smaller than the element to be inserted.
3. At this point, either the vacant slot is at the root, or the parent of the vacant slot is larger than the element to be inserted. Insert the element into the vacant slot.(copied from book)


2 Demote smaller parents
Insert 40
80
25
57
16
43
29
7
9
4
10
80
57
16
25
43
29
7
9
4
10


3
Insert element into vacant slot
Insert
40
80
40
57
16
25
43
29
7
9
4
10

12 HmaxHeap.h

```
*********************************************************************
* File:  H-maxHeap.h
* Author(s):  Natalie Peck, Gurpreet Singh, Justin Anaya, Sheharyar Khan
* Class:  CS-124-02
* Term:  Spring 2019
* Lab:  Team Project
* Date:  17 May 2019
* Despcription:
The class file containing declarations of all the functions needed to
create a max heap.
*********************************************************************
```




```
**Duplication Protection **
#ifndef MAXHEAP_H
#define MAXHEAP_H

**System Libraries **
#include <vector>
#include <iostream>
```

**Namespace Declaration **

```
using namespace std;
```

```
*********************************
*This class implements a heap.  *
*********************************

template<typename T>

class MaxHeap
{
        public:

                ********************Public Member Functions ********************

                Constructs an empty heap.
                MaxHeap();

                Adds a new element to this heap.element:  the element to add
                void push(T element);

                Gets the maximum element stored in this heap.returns:  the maximum
                    element
                T top() const;

                Removes the maximum element from this heap.
                void pop();
```

```
        Gets the size of this heap.returns:  the size
        int size() const;

        Re-heaps to preserve desired priority order
        void fix_heap_public();

        Print all entries in the heap
        void print_heap_public();

private:

        **********Private Variable(s) **********

        vector<T> elements;

        **********Private Member Functions **********
        Turns the tree back into a heap, provided only the rootnode violates the
            heap condition.
        void fix_heap();
```

```
****************************************

Returns the index of the left child.index:  the index of a node in this
    heapreturns:  the index of the left child of the given node
int get_left_child_index(int index) const;

****************************************

Returns the index of the right child.index:  the index of a node in this
    heapreturns:  the index of the right child of the given node
int get_right_child_index(int index) const;

****************************************

Returns the index of the parent.index:  the index of a node in this
    heapreturns:  the index of the parent of the given node
int get_parent_index(int index) const;
```

```
****************************************

Returns the value of the left child.index:  the index of a node in this
    heapreturns:  the value of the left child of the given node
T get_left_child(int index) const;

****************************************

Returns the value of the right child.index:  the index of a node in this
    heapreturns:  the value of the right child of the given node
T get_right_child(int index) const;

****************************************

Returns the value of the parent.index:  the index of a node in this
    heapreturns:  the value of the parent of the given node
T get_parent(int index) const;
```

```
                ****************************************

                Print all entries in the heap
                void print_heap();

};

********************MaxHeap() Constructor ********************

template<typename T>

MaxHeap<T>::MaxHeap()

{
        T dummy;
        elements.push_back(dummy);
}
```

```
**********************************************************************
**********************Public Member Functions **********************
**********************************************************************

**********************push() Function ***********************

template<typename T>

void MaxHeap<T>::push(T new_element)
{
          Add a new leaf
         T dummy;

         elements.push_back(dummy);

         int index = elements.size() - 1;

          Demote parents that are smaller than the new element
         while (index > 1 && get_parent(index) < new_element)
         {
                  elements[index] = get_parent(index);

                  index = get_parent_index(index);
         }

          Store the new element into the vacant slot
         elements[index] = new_element;
}
```

```
**********top() Function **********

template<typename T>

T MaxHeap<T>::top() const
{
        return elements[1];
}

**********pop() Function **********

template<typename T>

void MaxHeap<T>::pop()
{        Remove last element

        int last_index = elements.size() - 1;

        T last = elements[last_index];

        elements.pop_back();

        if (last_index > 1)
        {
                elements[1] = last;
                fix_heap();
        }
}
```

```
**********size() Function **********

template<typename T>

int MaxHeap<T>::size() const
{
        return elements.size() - 1;
}

**********fixHeapPublic() Function **********

template<typename T>

void MaxHeap<T>::fix_heap_public()
{
        fix_heap();
}

**********printHeapPublic() Function **********

template<typename T>

void MaxHeap<T>::print_heap_public()
{
        print_heap();
}
```

```
**********************************************************************
********************Private Member Functions *********************
**********************************************************************

**********************fixHeap() Function *******************

template<typename T>

void MaxHeap<T>::fix_heap()
{

        T root = elements[1];

        int last_index = elements.size() - 1;

         Promote children of removed root while they are smaller than root

        int index = 1;

        bool done = false;

        while (!done)
        {
                int child_index = get_left_child_index(index);
                if (child_index <= last_index)
                {
                        Get larger child

                        Get left child first
                       T child = get_left_child(index);
```

```
                        Use right child instead if it is larger
                        if (get_right_child_index(index) <= last_index
                        && child < get_right_child(index))
                        {
                                child_index = get_right_child_index(index);
                                child = get_right_child(index);
                        }

                        Check if larger child is larger than root
                        if (root < child)
                        {
                                Promote child
                                elements[index] = child;
                                index = child_index;
                        }

                        else
                        {  Root is larger than both children
                                done = true;
                        }
                }

                else
                {  No children
                        done = true;
                }
        }

        Store root element in vacant slot
        elements[index] = root;
}
```

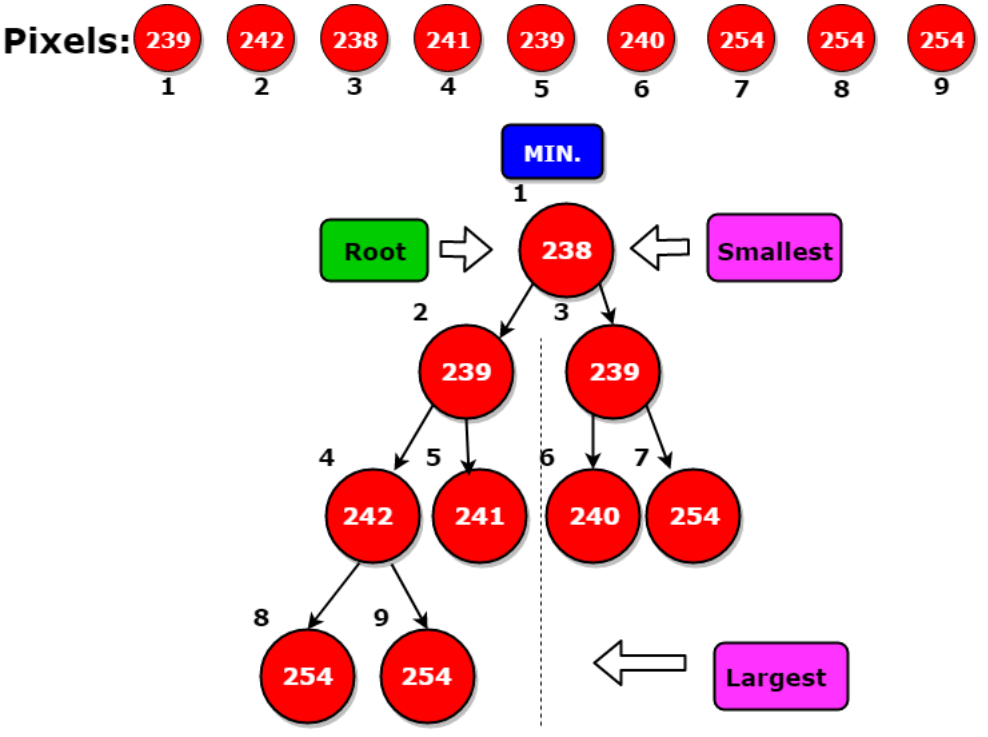
```
***************getLeftChildIindex() Function ***************

template<typename T>

int MaxHeap<T>::get_left_child_index(int index) const
{
        return 2 * index;
}

***************getRightChildIndex() Function ***************

template<typename T>

int MaxHeap<T>::get_right_child_index(int index) const
{
        return 2 * index + 1;
}

***************getParentIndex() Function ***************

template<typename T>

int MaxHeap<T>::get_parent_index(int index) const
{
        return index / 2;
}
```

```
******************getLeftChild() Function ********************

template<typename T>

T MaxHeap<T>::get_left_child(int index) const
{
        return elements[2 * index];
}

*****************getRightChild() Function ******************

template<typename T>

T MaxHeap<T>::get_right_child(int index) const
{
        return elements[2 * index + 1];
}

******************getParent() Function ********************

template<typename T>

T MaxHeap<T>::get_parent(int index) const
{
        return elements[index / 2];
}
```

```
*****************printHeap() Function ******************

template<typename T>

void MaxHeap<T>::print_heap()
{
        for(int i = 1; i < elements.size(); i++)
        {
                std::cout << elements[i] << std::endl;
        }
}


#endif  end of MAXHEAP.H
```

13 HminHeap.h

```
*********************************************************************
* File:  H-minHeap.h
* Author(s):  Natalie Peck, Gurpreet Singh, Justin Anaya, Sheharyar Khan
* Class:  CS-124-02
* Term:  Spring 2019
* Lab:  Team Project
* Date:  17 May 2019
* Despcription:
The class file containing declarations of all the functions needed to
create a min heap.
*********************************************************************
```




```
**Duplication Protection **
#ifndef MINHEAP_H
#define MINHEAP_H

**System Libraries **
#include <vector>
#include <iostream>
```

**Namespace Declaration **

```
using namespace std;
```

```
*********************************
*This class implements a heap.  *
*********************************

template<typename T>

class MinHeap
{
        public:

                ********************Public Member Functions ********************

                Constructs an empty heap.
                MinHeap();

                Adds a new element to this heap.Parameter element:  the element to add
                void push(T element);

                Gets the minimum element stored in this heap.returns:  the minimum
                    element
                T top() const;

                Removes the minimum element from this heap.
                void pop();
```

```
        Gets the size of this heap.returns:  the size
        int size() const;

        Re-heaps to preserve desired priority order
        void fix_heap_public();

        Print all entries in the heap
        void print_heap_public();

private:

        **********Private Variable(s) **********

        vector<T> elements;

        **********Private Member Functions **********
        Turns the tree back into a heap, provided only the rootnode violates the
            heap condition.
        void fix_heap();
```

```
****************************************

Returns the index of the left child.Parameter index:  the index of a
    node in this heapreturns:  the index of the left child of the given
    node
int get_left_child_index(int index) const;

****************************************

Returns the index of the right child.Parameter index:  the index of a
    node in this heapreturns:  the index of the right child of the given
    node
int get_right_child_index(int index) const;

****************************************

Returns the index of the parent.Parameter index:  the index of a node in
    this heapreturns:  the index of the parent of the given node
int get_parent_index(int index) const;
```

```
*****************************************

Returns the value of the left child.Parameter index:  the index of a
    node in this heapreturns:  the value of the left child of the given
    node
T get_left_child(int index) const;

*****************************************

Returns the value of the right child.Parameter index:  the index of a
    node in this heapreturns:  the value of the right child of the given
    node
T get_right_child(int index) const;

*****************************************

Returns the value of the parent.Parameter index:  the index of a node in
    this heapreturns:  the value of the parent of the given node
T get_parent(int index) const;
```

```
                ****************************************

                Print all entries in the heap
                void print_heap();

};

********************MinHeap() Constructor ********************

template<typename T>

MinHeap<T>::MinHeap()

{
        T dummy;
        elements.push_back(dummy);
}
```

```
**********************************************************************
**********************Public Member Functions **********************
**********************************************************************

**********************push() Function ***********************

template<typename T>

void MinHeap<T>::push(T new_element)
{
          Add a new leaf
         T dummy;

         elements.push_back(dummy);

         int index = elements.size() - 1;

          Demote parents that are bigger than the new element
         while (index > 1 && get_parent(index) > new_element)
         {
                  elements[index] = get_parent(index);

                  index = get_parent_index(index);
         }

          Store the new element into the vacant slot
         elements[index] = new_element;
}
```

```
**********top() Function **********

template<typename T>

T MinHeap<T>::top() const
{
        return elements[2];
}

**********pop() Function **********

template<typename T>

void MinHeap<T>::pop()
{        Remove last element

        int last_index = elements.size() - 1;

        T last = elements[last_index];

        elements.pop_back();

        if (last_index > 1)
        {
                elements[1] = last;
                fix_heap();
        }
}
```

```
**********size() Function **********

template<typename T>

int MinHeap<T>::size() const
{
        return elements.size() - 1;
}

**********fixHeapPublic() Function **********

template<typename T>

void MinHeap<T>::fix_heap_public()
{
        fix_heap();
}

**********printHeapPublic() Function **********

template<typename T>

void MinHeap<T>::print_heap_public()
{
        print_heap();
}
```

```
**********************************************************************
********************Private Member Functions *********************
**********************************************************************

**********************fixHeap() Function *******************

template<typename T>

void MinHeap<T>::fix_heap()
{

        T root = elements[1];

        int last_index = elements.size() - 1;

         Promote children of removed root while they are bigger than root

        int index = 1;

        bool done = false;

        while (!done)
        {
                int child_index = get_left_child_index(index);
                if (child_index <= last_index)
                {
                        Get smaller child

                        Get left child first
                       T child = get_left_child(index);
```

```
                        Use right child instead if it is smaller
                        if (get_right_child_index(index) <= last_index
                        && child > get_right_child(index))
                        {
                                child_index = get_right_child_index(index);
                                child = get_right_child(index);
                        }

                        Check if smaller child is smaller than root
                        if (root > child)
                        {
                                Promote child
                                elements[index] = child;
                                index = child_index;
                        }

                        else
                        {  Root is smaller than both children
                                done = true;
                        }
                }

                else
                {  No children
                        done = true;
                }
        }

        Store root element in vacant slot
        elements[index] = root;
}
```

```
***************getLeftChildIndex() Function ***************

template<typename T>

int MinHeap<T>::get_left_child_index(int index) const
{
        return 2 * index;
}

***************getRightChildIndex() Function ***************

template<typename T>

int MinHeap<T>::get_right_child_index(int index) const
{
        return (2 * index) + 1;
}

***************getParentIndex() Function ***************

template<typename T>

int MinHeap<T>::get_parent_index(int index) const
{
        return index / 2;
}
```

```
******************getLeftChild() Function ********************

template<typename T>

T MinHeap<T>::get_left_child(int index) const
{
        return elements[2 * index];
}

*****************getRightChild() Function *******************

template<typename T>

T MinHeap<T>::get_right_child(int index) const
{
        return elements[2 * index + 1];
}

******************getParent() Function ********************

template<typename T>

T MinHeap<T>::get_parent(int index) const
{
        return elements[index / 2];
}
```

```
*****************printHeap() Function *****************

template<typename T>

void MinHeap<T>::print_heap()
{
        for(int i = 1; i < elements.size(); i++)
        {
                std::cout << elements[i] << std::endl;
        }
}

#endif  end of MINHEAP.H
```