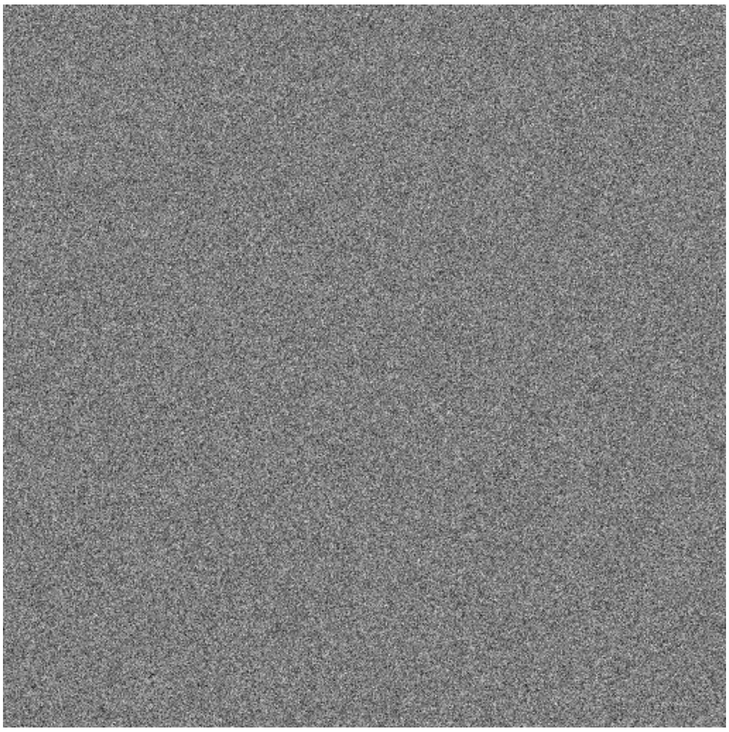
Dorian Dressler **ICP-3038 Computer Vision** **DUE: 16-NOV-2016**
eeu436 **Assignment 1: Logbook**

1. Test log:

Tests of the Image Class' functions were carried out with the following images:

Lena.pgm, 512x512px



Noise.pgm, Sizes: 512x512, 412x412 (small), 612x612 (large)

Ramp.pgm , Sizes: 512x512, 412x412 (small), 612x612 (large)

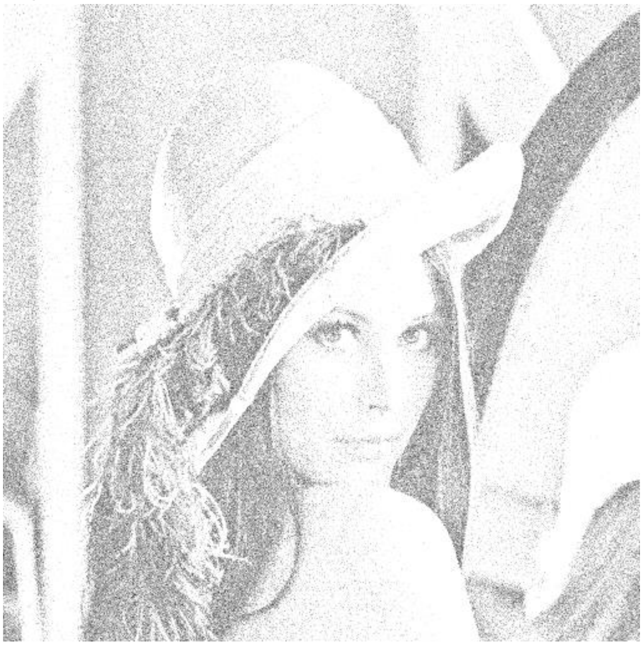
Test structure: Tests were carried out using the above images. The expected results were determined by the operations carried out with ImageJ. Actual results were gathered with the Image class implemented in C++.

The tests have the following layout:
- Type of operators
- operator
- Result comparison

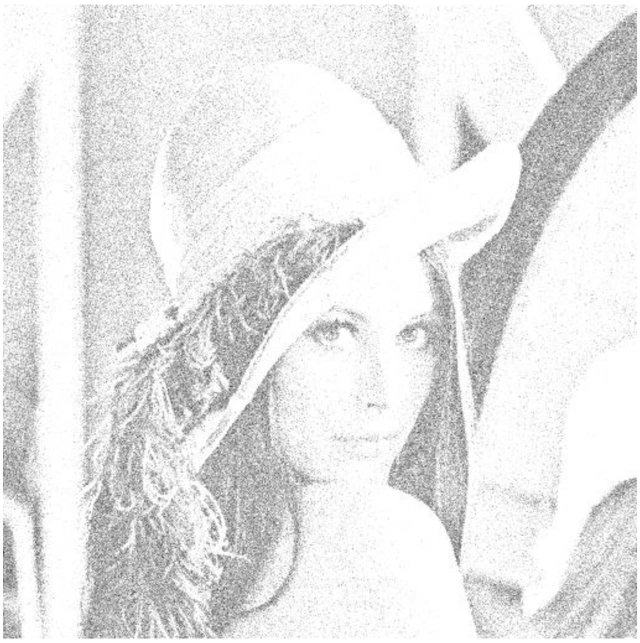
A critical evaluation is provided on page 25. The appendix with the code begins on page 26.

Arithmetic operators using another image:

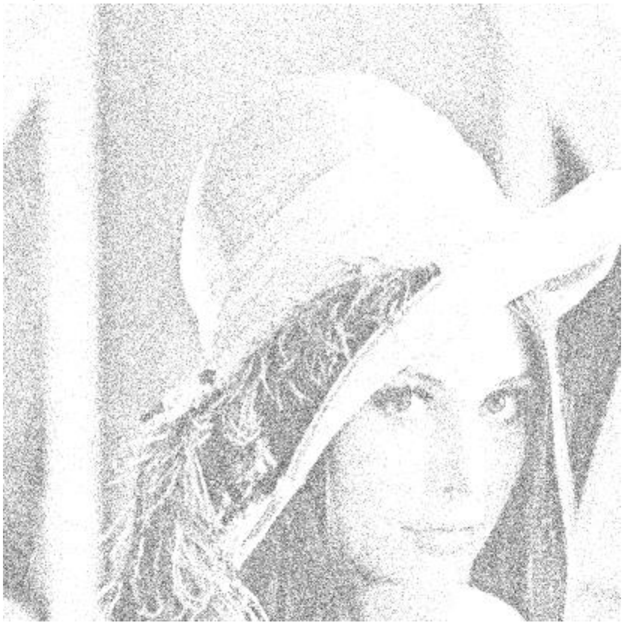
```
Image operator+(const Image& anImage);
This functions adds two images and returns a new composite of both.

Parameters used:
lena.pgm and noise.pgm (same size)
Expected Result:
```



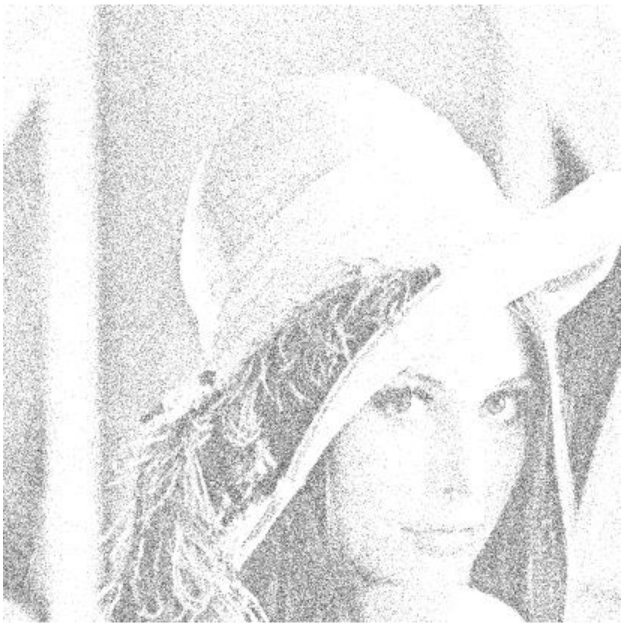
```
Actual result:
```



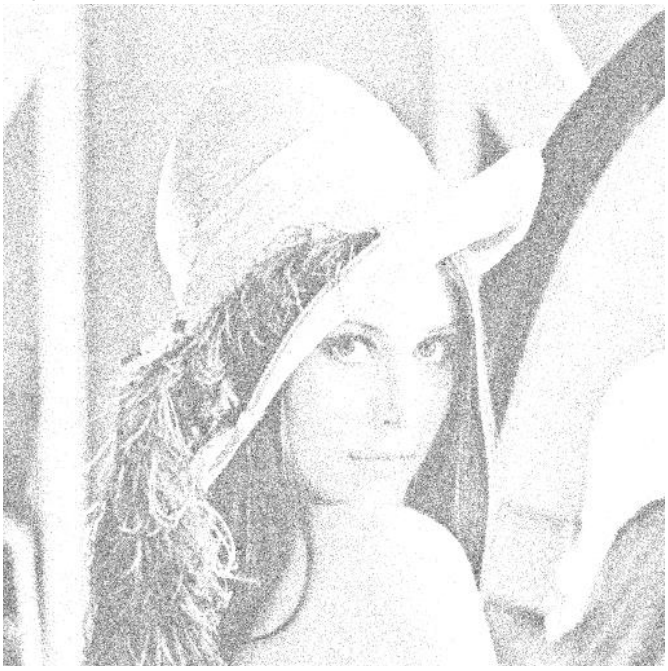
```
Parameters used:
lena.pgm and noise.pgm (noise.pgm = small)
Expected result:
```



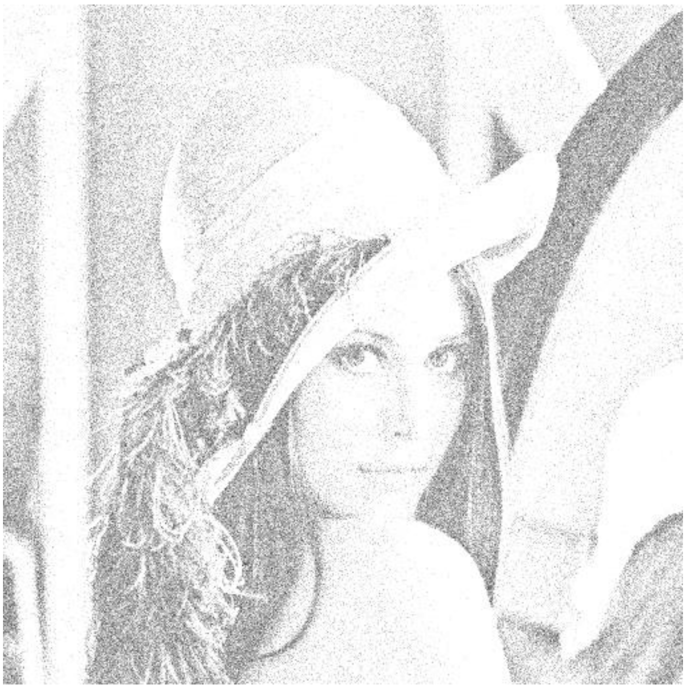
Actual result:



Parameters used:
lena.pgm and noise.pgm (noise.pgm = big)
Expected result:



Actual result:



```
Image operator-(const Image& anImage);
```

Subtracts an image from another one and returns the composite of both in a new image.

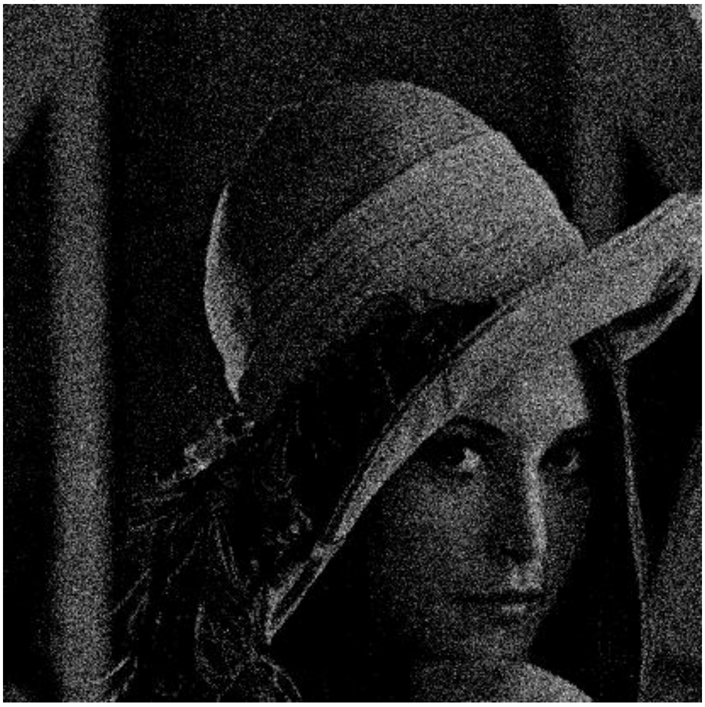
Parameters used:

lena.pgm, noise.pgm (equal size)

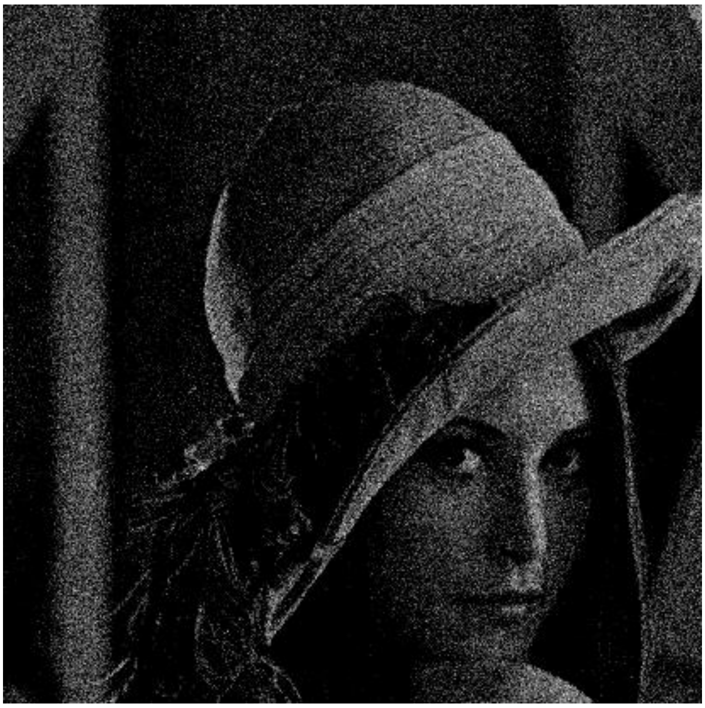
Expected result:

Actual result:

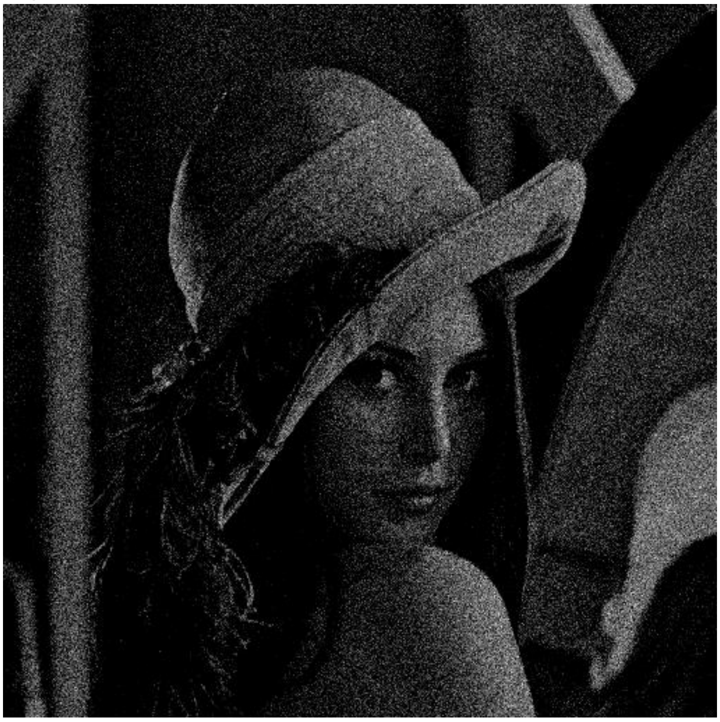
Lena.pgm, noise.pgm (smaller)
Expected result:



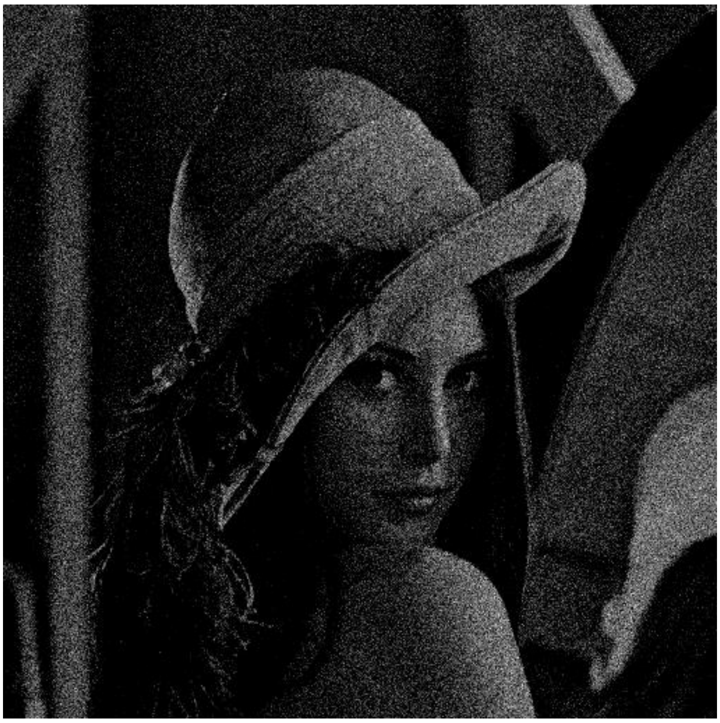
Actual result:



lena.pgm, noise.pgm (bigger)
Expected result:



Actual result:



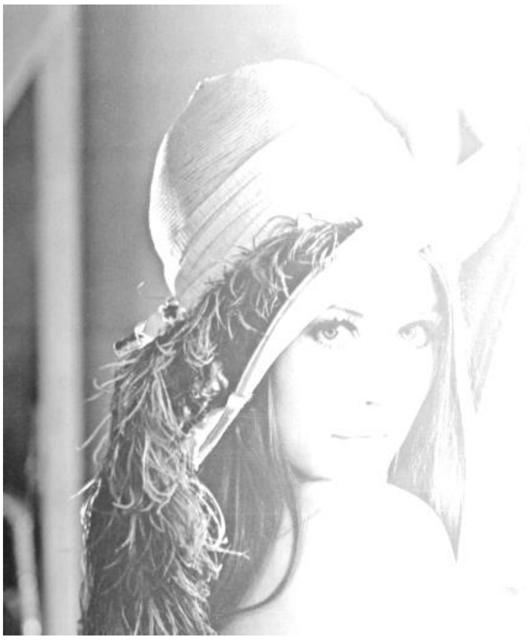
Arithmetic assignment operators using another image

```
Image& operator+=(const Image& anImage);
```

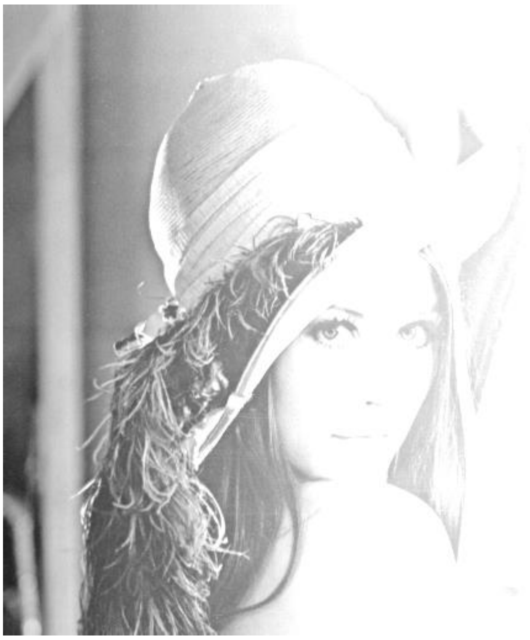
Adds an image (pixelwise) to the current image and returns a reference to the current image.

Parameters used:
lena.pgm, ramp.pgm (equal size)

Expected result:

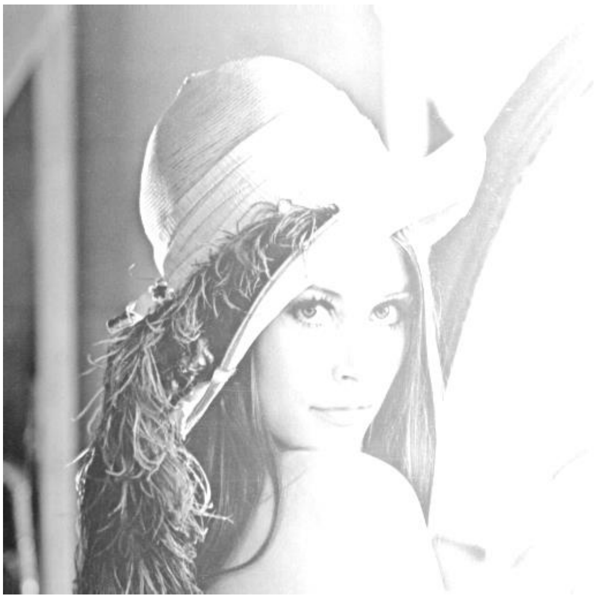


Actual result:

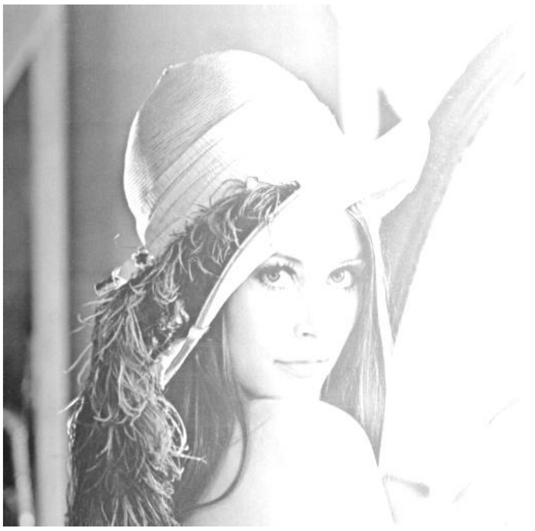


Pass/fail: pass

Lena.pgm, ramp.pgm(bigger)
Expected result:

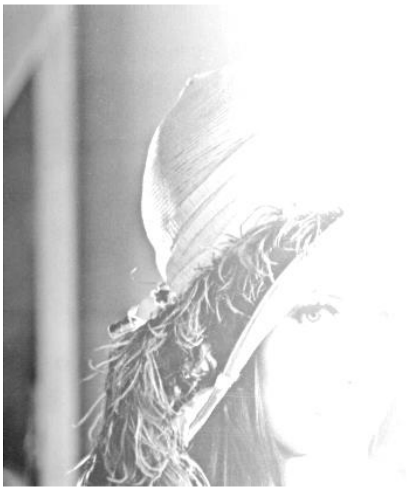


Actual result:

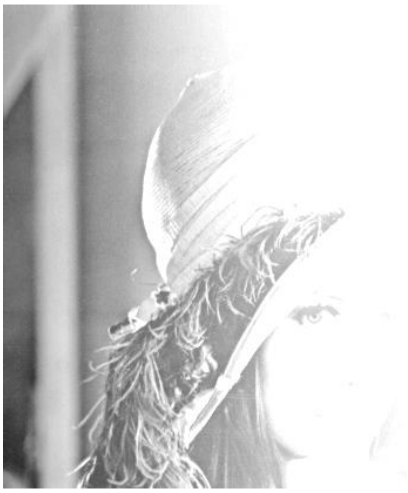


Pass/fail: pass

lena.pgm, ramp.pgm(smaller)
Expected result:



Actual result:



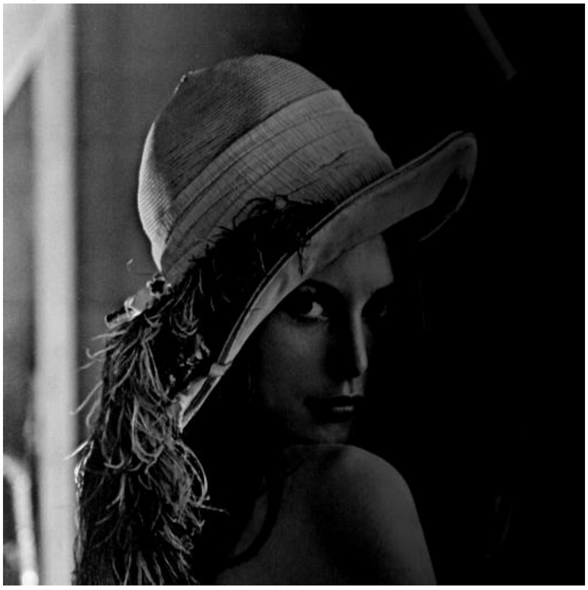
Pass/fail: pass

```
Image& operator-=(const Image& anImage);
```

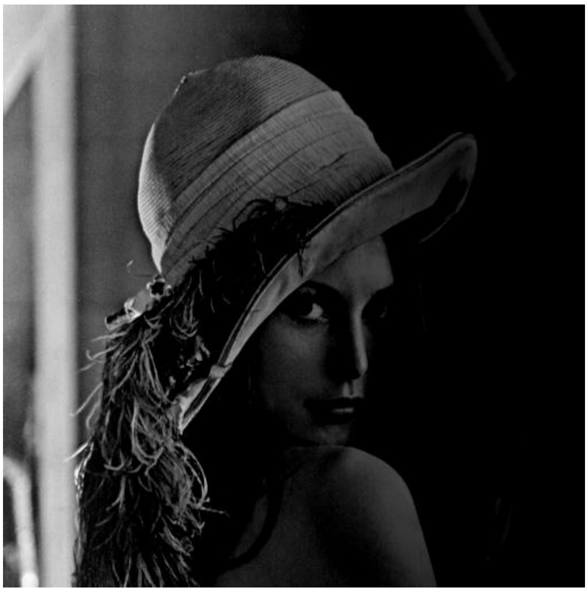
Subtracts an image (pixelwise) from the current image and returns a reference to the current image.

Parameters used:
lena.pgm, ramp.pgm (equal size)

Expected result:



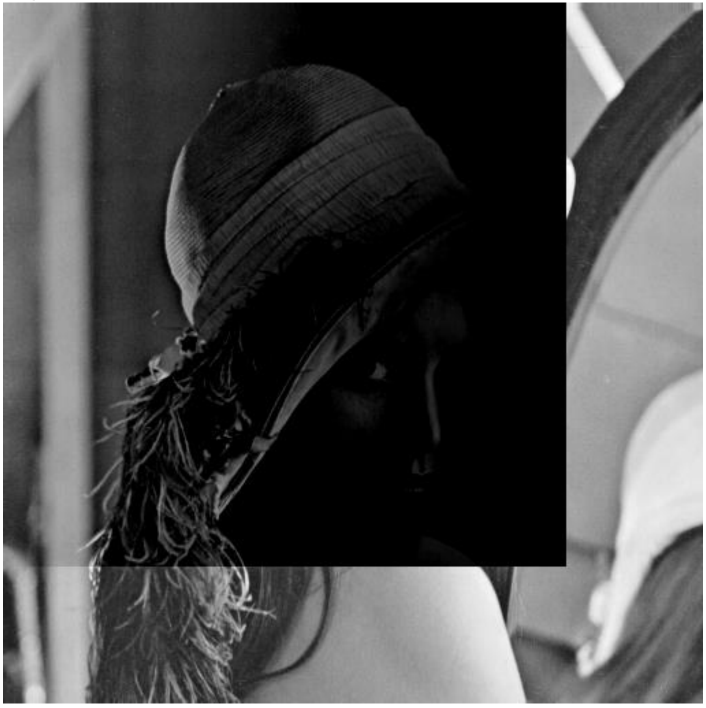
Actual result:



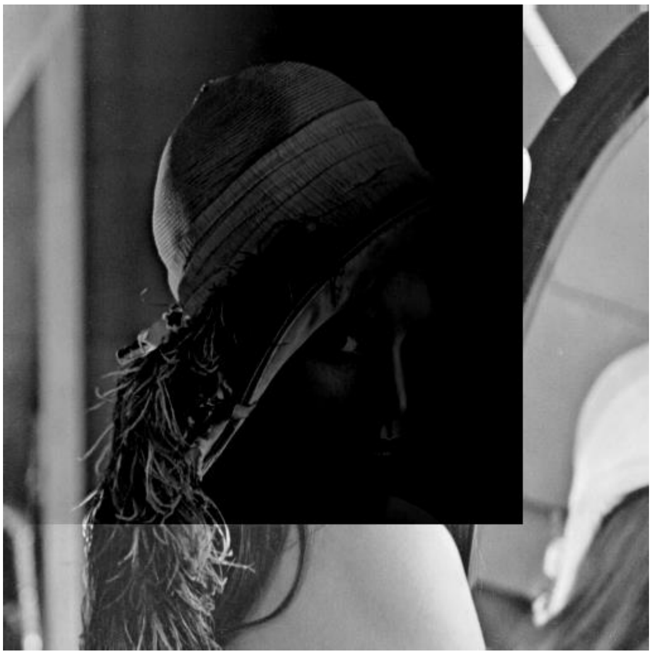
Pass/fail: pass

lena.pgm, ramp.pgm (smaller)

Expected result:



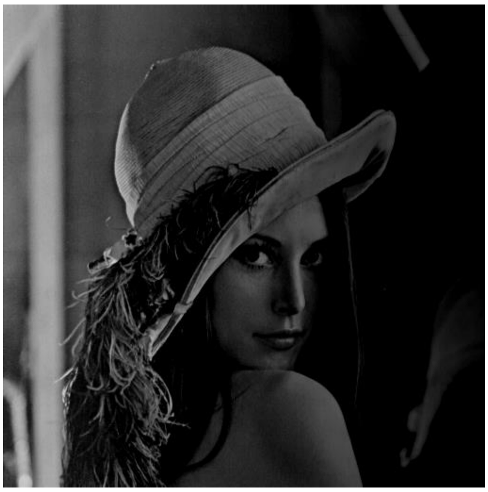
Actual result:



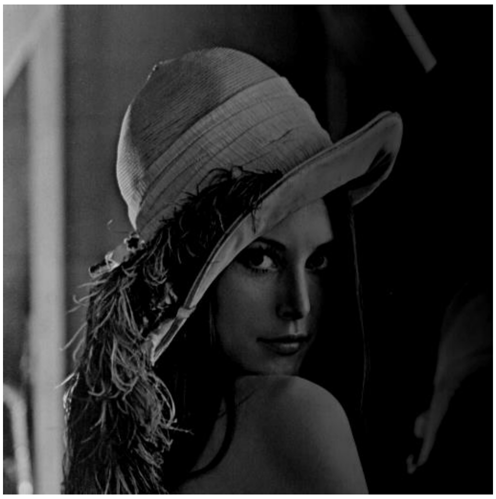
Pass/fail: pass

Lena.pgm, ramp.pgm(bigger)

Expected result:



Actual result:



Pass/fail: pass

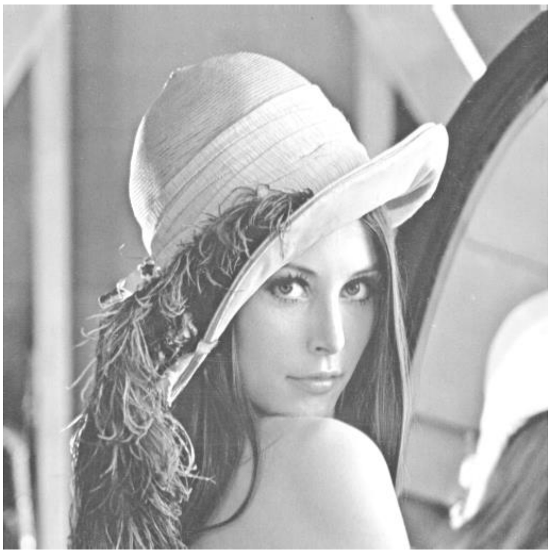
Arithmetic operators using a floating point parameter:

```
Image operator+(float aValue);
```

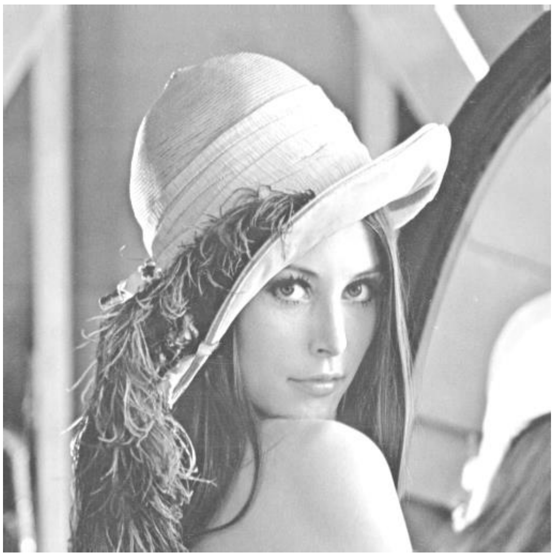
Addition operator, add a value to each pixel.

Parameters used:
lena.pgm, aFloat = 50

Expected Result:



Actual result:



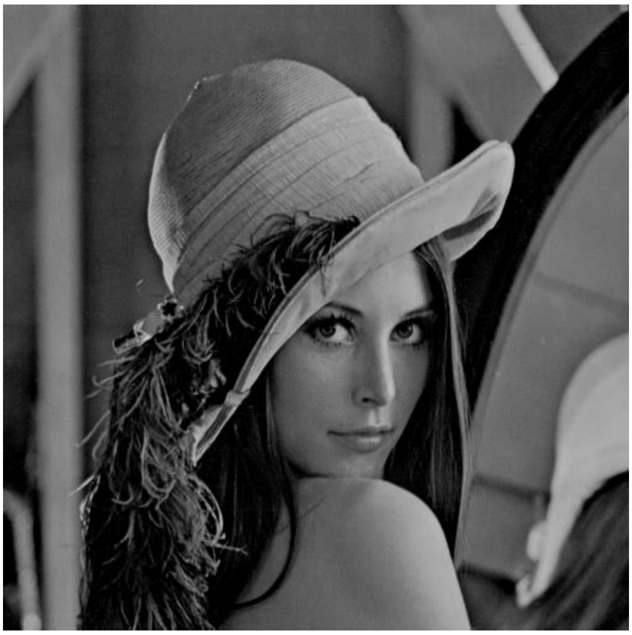
Pass/fail: pass

```
Image operator-(float aValue);
```

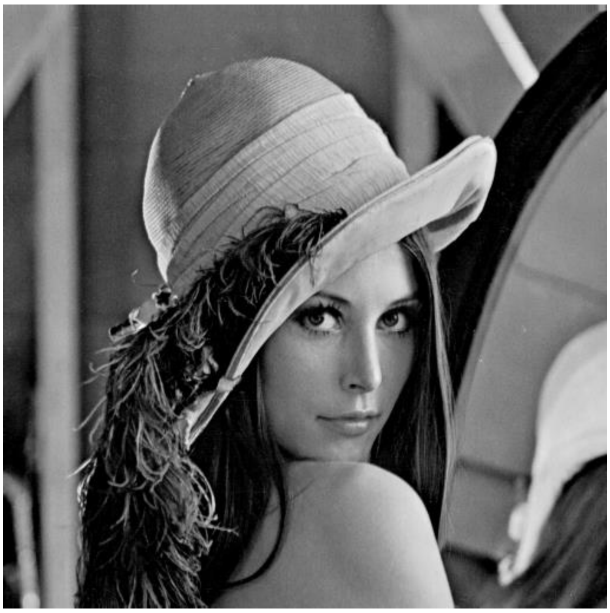
Subtraction operator, subtracts a value from each pixel.

Parameters used:
lena.pgm, aFloat = 50

Expected result:



Actual result:



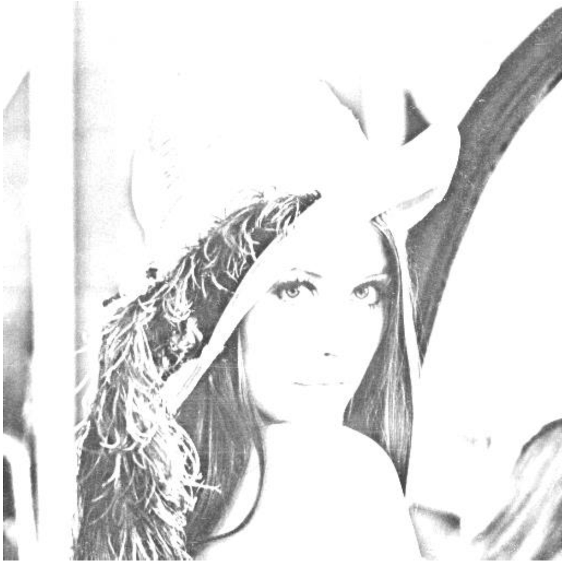
Pass/fail: pass

```
Image operator*(float aValue);
```

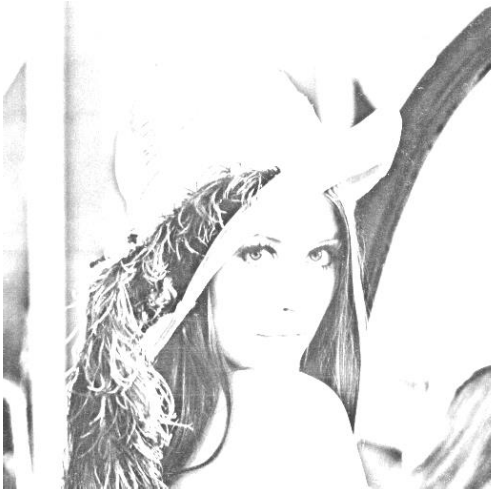
Multiplication operator, multiplies every pixel of the image by floating point value

Parameters used:
lena.pgm, aFloat = 2.5

Expected result:



Actual result:



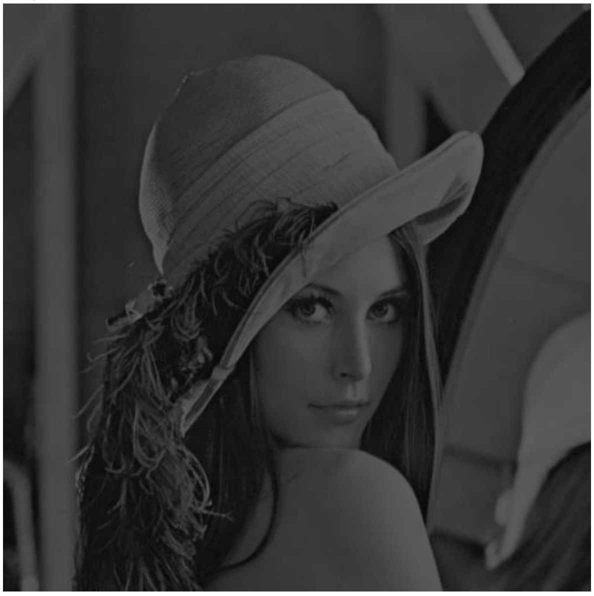
Pass/fail: pass

```
Image operator/(float aValue);
```

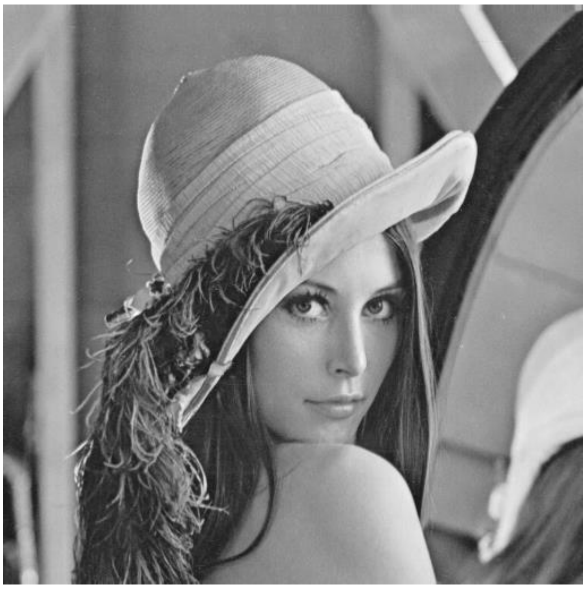
Division operator, divides each pixel of the image by aFloat.

Parameters used:
lena.pgm, aFloat = 2.5

Expected result:



Actual result:



Comment: this operator did not yield the expected result.

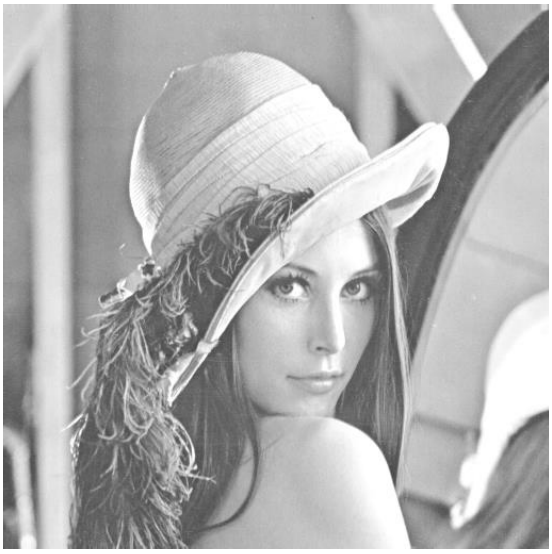
Arithmetic assignment operators using a floating point parameter:

```
Image operator+=(float aValue);
```

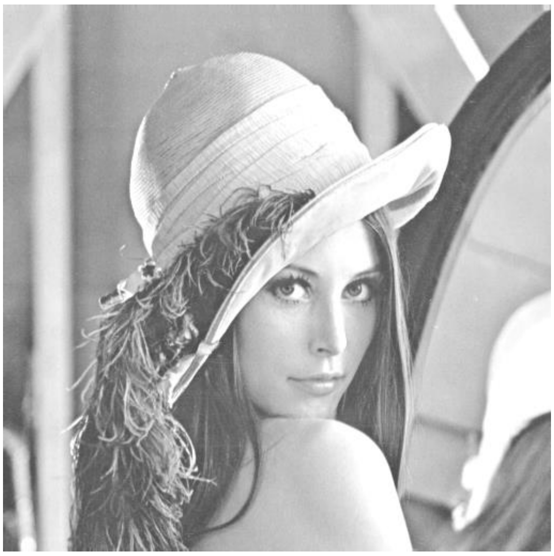
Addition operator, add a value to each pixel of the current image.

Parameters used:
lena.pgm, aFloat = 50

Expected Result:



Actual result:

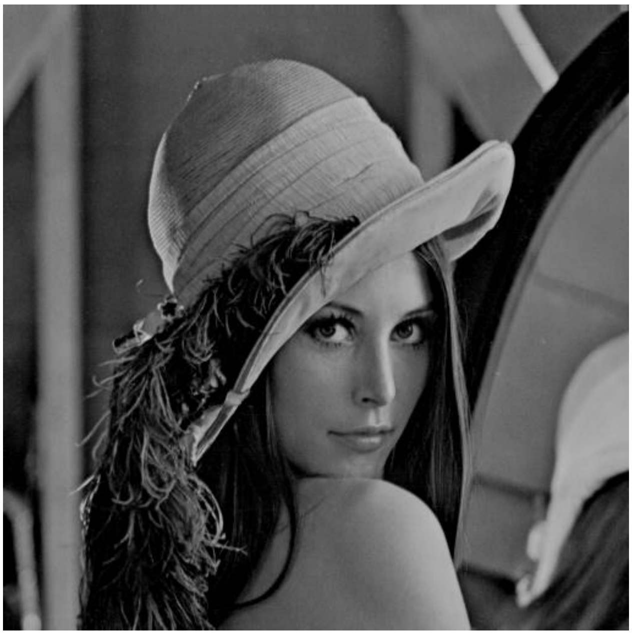


```
Image operator-=(float aValue);
```

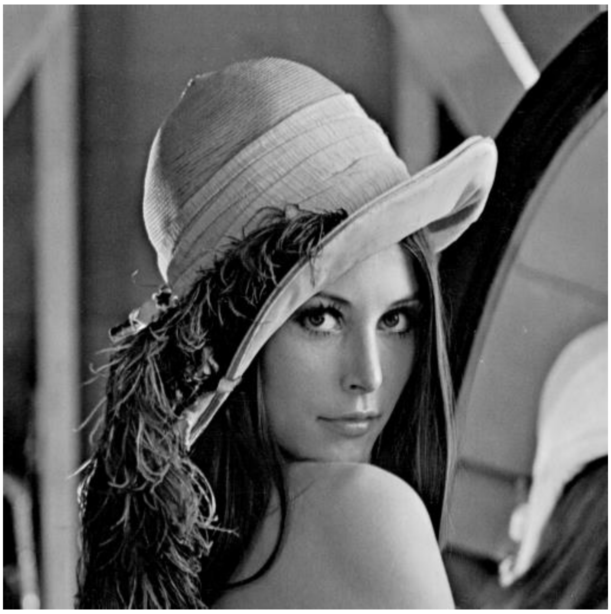
Subtraction operator, subtracts a value from each pixel.

Parameters used:
lena.pgm, aFloat = 50

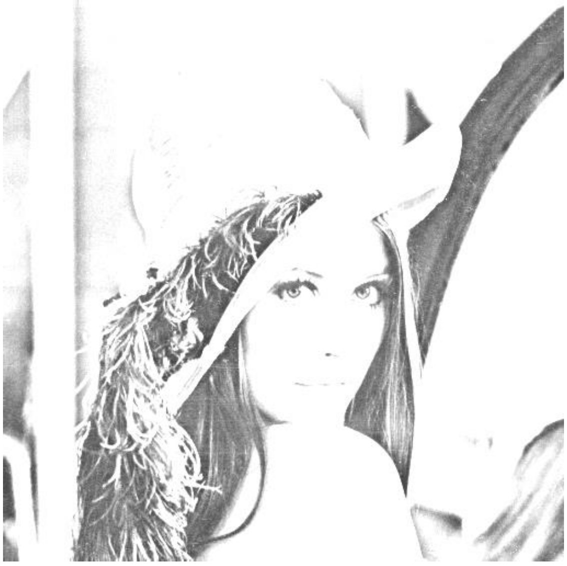
Expected result:



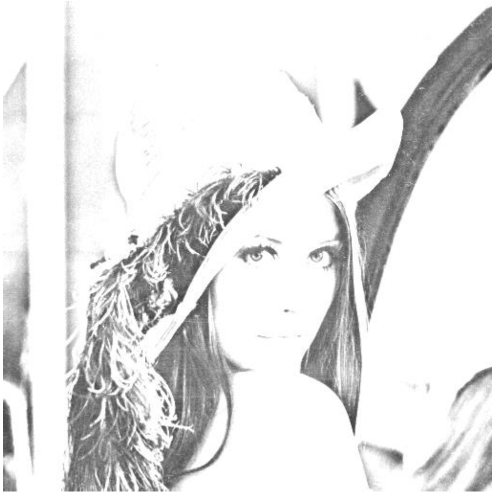
Actual result:



```
Image operator*=(float aValue);
Multiplication operator, multiplies every pixel of the image by floating point value

Parameters used:
lena.pgm, aFloat = 2.5

Expected result:
```



```
Actual result:
```

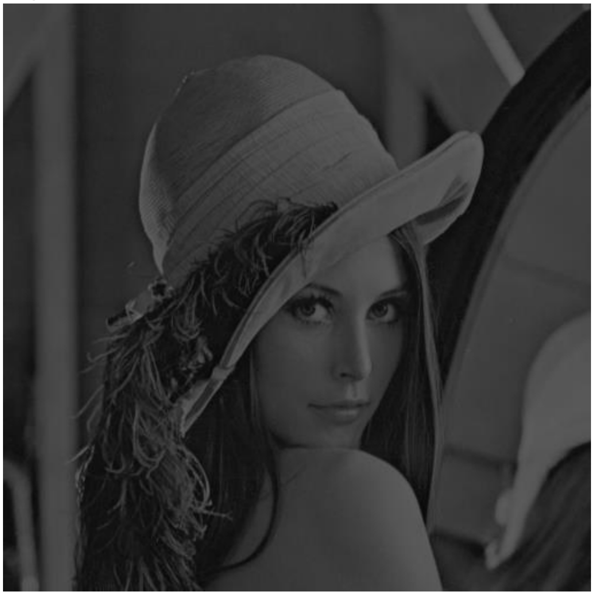


```
Image operator/=(float aValue);
```

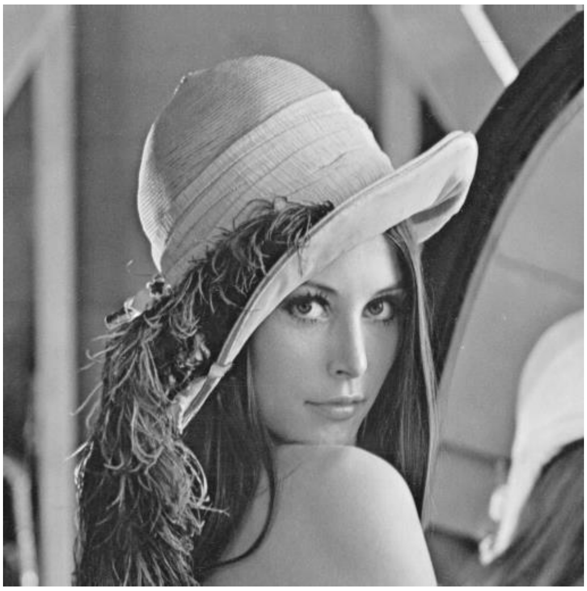
Division operator, divides each pixel of the image by aFloat.

Parameters used:
lena.pgm, aFloat = 2.5

Expected result:



Actual result:

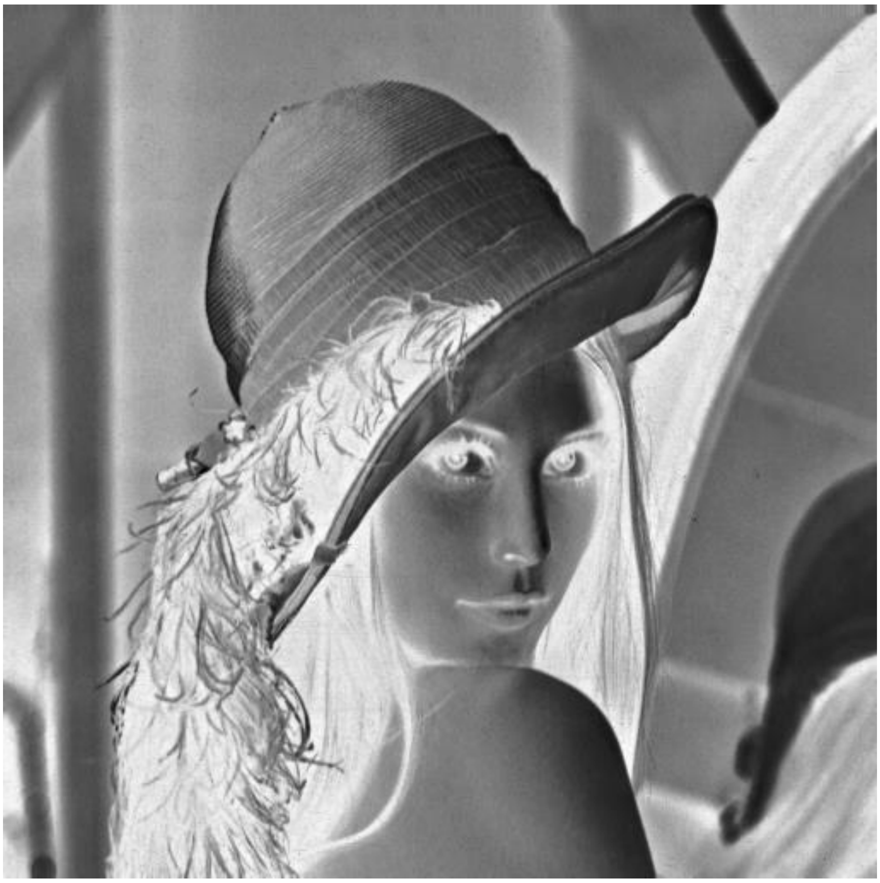


Comment: this operator did not yield the expected result.

```
Image Image::operator!()
```

Negation operator

Actual result:



Setters and getters:

```
void setPixel(unsigned int i, unsigned int j, float aValue);

float getPixel(unsigned int i, unsigned int j) const;
```

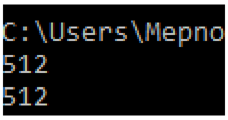
The test of these two functions was carried out using the lenga.pgm image.

Test procedure:
- getPixel(25, 25)
- setPixel(25,25, 125) , sets pixel at 25, 25 to 125
- getPixel(25,25)

Initial state: 163
Expected value after call to setPixel: 125
Actual result: 125

```
unsigned int getHeight() const; unsigned int getWidth() const;
```

This test was carried out using the lenga.pgm image, size 512x512

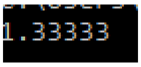


```
C:\Users\Mepno
512
512
```

Top parameter height, bottom parameter width.

```
float getAspectRatio();
```

Tested with an image size 800x600.
Expected result 1.34
Actual result:



```
1.33333
```

2. Critical Evaluation:

Overall, I found this assignment relatively straightforward and I didn't encounter any major problems with the implementation of the overloaded operators, save for the division operator. I implemented the operators that used images as parameters in a way that allowed for the images used to be of different size to the original image. As for the division operator, I was not able to locate the reason as to why it wasn't and still is not working as expected.

I could've done a more coherent job with testing and actually provided Test.cpp with a command line interface that would have allowed me to call the functions directly using a switch statement, in order to simplify the process. Instead I called each operator discretely, resulting in a largely unsanitary file which made keeping track of the testing process rather difficult.

Unfortunately, I did not have the time to implement the ASCII read and write method, which the program would have benefitted from.

<u>3. Code:</u>

```
#ifndef IMAGE_H
#define IMAGE_H



/**
********************************************************************************
*
*       @file           Image.h
*
*       @brief          File contains function headers for the image class.
*
*       @version        1.0
*
*  @todo      Implement the default constructor; x

*  @todo      Implement the copy constructor; x
*  @todo      Implement the destructor  x
*             (don't forget to release the memory if needed);
*  @todo      Add the assignment operator; x
*  @todo      Imaplement the code to read an image from an ASCII file
*             as follows:
*             - Each line of the ASCII file corresponds to a line of
*               the image;
*             - Each pixel is the ASCII file corresponds to
*               a floating point number;
*             - Two successive pixels in the image are separated
*               by a space character in the ASCII file
*               the image.
*  @todo      Implement the code to save an image in an ASCII file;
*  @todo      Implement the arithmetic operators x
*            (with a float as a parameter);
*  @todo      Implement the arithmetic operators x
*            (with an image as a parameter);
*  @todo      Implement the corresponding arithmetic/assignment  operators; x
*  @todo      Implement the negation operator to return the negative image; x
*  @todo      Add an accessor on the width of the image;  x
*  @todo      Add an accessor on the height of the image; x
*  @todo      Add a method returning the aspect ratio;
*  @todo      Add a method to set the value of a given pixel; x
*  @todo      Add a method returning the value of a given pixel; x
*  @todo      Add a method returning the smallest value in the image; x
*  @todo      Add a method returning the highest value in the image. x
*
*          @date              25/10/2016
*
*          @author                        Dorian B. Dressler (eeu436@bangor@ac.uk)
*
*
********************************************************************************
*/


//******************************************************************************
//         Include
//******************************************************************************
#include <string>



//==============================================================================
/**
*          @class  Image
*          @brief  Image is a class to manage a greyscale image.
*/
//===========================================================================
class Image
//---------------------------------------------------------------------------
{
//***************************************************************************
public:
   //-----------------------------------------------------------------------
   /// Default constructor.
   //-----------------------------------------------------------------------
   Image();



   //---------------------------------------------------------------------
   /// Copy constructor.
   /**
   * @param anImage: the image to copy
   */
   //---------------------------------------------------------------------
   Image(const Image& anImage);



   //---------------------------------------------------------------------
   /// Destructor.
   //---------------------------------------------------------------------
   ~Image();



   //---------------------------------------------------------------------
   /// Assignment operator (also called copy operator).
```

```
/**
* @param anImage: the image to copy
* @return the updated version of the current image
*/
//----------------------------------------------------------------------
Image& operator=(const Image& anImage);


//----------------------------------------------------------------------
/// Release the memory.
//----------------------------------------------------------------------
void destroy();


//----------------------------------------------------------------------
/// Addition operator. Add anImage
/**
* @param anImage: the image to add
* @return the resulting image
*/
//----------------------------------------------------------------------
Image operator+(const Image& anImage);


//----------------------------------------------------------------------
/// Subtraction operator. Add anImage
/**
* @param anImage: the image to subtract
* @return the resulting image
*/
//----------------------------------------------------------------------
```

```
Image operator-(const Image& anImage);



//----------------------------------------------------------------------
/// Addition assignment operator. Add anImage
/**
* @param anImage: the image to add
* @return the updated version of the current image
*/
//----------------------------------------------------------------------
Image& operator+=(const Image& anImage);



//----------------------------------------------------------------------
/// Subraction assignment operator. Add anImage
/**
* @param anImage: the image to subtract
* @return the updated version of the current image
*/
//----------------------------------------------------------------------
Image& operator-=(const Image& anImage);



//----------------------------------------------------------------------
/// Addition operator. Add aValue to every pixel of the image
/**
* @param aValue: the value to add
* @return the resulting image
*/
//----------------------------------------------------------------------
Image operator+(float aValue);
```

```
//----------------------------------------------------------------------
/// Subtraction operator. Subtract aValue to every pixel of the image
/**
* @param aValue: the value to subtract
* @return the resulting image
*/
//----------------------------------------------------------------------
Image operator-(float aValue);


//----------------------------------------------------------------------
/// Multiplication operator. Multiply every pixel of the image by aValue
/**
* @param aValue: the value for the multiplication
* @return the resulting image
*/
//----------------------------------------------------------------------
Image operator*(float aValue);


//----------------------------------------------------------------------
/// Division operator. Divide every pixel of the image by aValue
/**
* @param aValue: the value for the division
* @return the resulting image
*/
//----------------------------------------------------------------------
Image operator/(float aValue);
```

```
//----------------------------------------------------------------------
/// Addition operator. Add aValue to every pixel of the image
/**
* @param aValue: the value to add
* @return the updated version of the current image
*/
//----------------------------------------------------------------------
Image& operator+=(float aValue);



//----------------------------------------------------------------------
/// Subtraction operator. Subtract aValue to every pixel of the image
/**
* @param aValue: the value to subtract
* @return the updated version of the current image
*/
//----------------------------------------------------------------------
Image& operator-=(float aValue);



//----------------------------------------------------------------------
/// Multiplication operator. Multiply every pixel of the image by aValue
/**
* @param aValue: the value for the multiplication
* @return the updated version of the current image
*/
//----------------------------------------------------------------------
Image& operator*=(float aValue);
```

```
//-----------------------------------------------------------------------
/// Division operator. Divide every pixel of the image by aValue
/**
* @param aValue: the value for the division
* @return the updated version of the current image
*/
//-----------------------------------------------------------------------
Image& operator/=(float aValue);


//-----------------------------------------------------------------------
/// Negation operator. Compute the negative of the current image.
/**
* @return the negative image
*/
//-----------------------------------------------------------------------
Image operator!();


//-----------------------------------------------------------------------
/// Compute the maximum pixel value in the image
/**
* @return the maximum pixel
*/
//-----------------------------------------------------------------------
float getMaxValue() const;


//-----------------------------------------------------------------------
/// Add aShiftValue to every pixel, then multiply every pixel
/// by aScaleValue
```

```
/**
* @param aShiftValue: the shift parameter of the filter
* @param aScaleValue: the scale parameter of the filter
*/
//----------------------------------------------------------------------
void shiftScaleFilter(float aShiftValue, float aScaleValue);


//----------------------------------------------------------------------
/// Load an image from a PGM file
/**
* @param aFileName: the name of the file to load
*/
//----------------------------------------------------------------------
void loadPGM(const char* aFileName);


//----------------------------------------------------------------------
/// Load an image from a PGM file
/**
* @param aFileName: the name of the file to load
*/
//----------------------------------------------------------------------
void loadPGM(const std::string& aFileName);


//----------------------------------------------------------------------
/// Save the image in a PGM file
/**
* @param aFileName: the name of the file to write
*/
```

```
//----------------------------------------------------------------------
void savePGM(const char* aFileName);



//----------------------------------------------------------------------
/// Save the image in a PGM file
/**
* @param aFileName: the name of the file to write
*/
//----------------------------------------------------------------------
void savePGM(const std::string& aFileName);



    //----------------------------------------------------------------------
/// Change a pixel in the PGM file
/**
* @param i: the row of the pixel to set
    * @param i: the column of the pixel to set
    * @param aValue: the value of the pixel to set
*/
//----------------------------------------------------------------------
void setPixel(unsigned int i, unsigned int j, float aValue);



    //----------------------------------------------------------------------
/// Change a pixel in the PGM file
/**
* @param i: the row of the pixel to get
    * @param i: the column of the pixel to get
    * @return aValue: the value of the pixel to get
*/
```

```
        float getPixel(unsigned int i, unsigned int j) const;



        //----------------------------------------------------------------------
        /// Gets the width of an image.
        /**
        * @return m_width: the width of the image
        */
        unsigned int getWidth() const;

        //----------------------------------------------------------------------
        /// Gets the height of an image.
        /**
        * @return m_height: the height of the image
        */
        unsigned int getHeight() const;



        //----------------------------------------------------------------------
        /// Gets the aspect ratio of an image.
        /**
        * @return the image's aspect ratio
        */
        float getAspectRatio();

  //----------------------------------------------------------------------

//*****************************************************************************
private:
    /// Number of pixel along the horizontal axis
    unsigned int m_width;
```

```
   /// Number of pixel along the vertical axis
   unsigned int m_height;



   /// The pixel data
   float* m_p_image;
};

#endif

/**
****************************************************************************************
*
*          @file               Image.cpp
*
*          @brief              Constructor file for the Image class.
*
*          @version            1.0
*
*          @date               25/10/2016
*
*          @author                         Dorian B. Dressler (eeu436@bangor@ac.uk)
*
*
****************************************************************************************
*/



//*************************************************************************************
```

```
//		Define
//******************************************************************************
#define LINE_SIZE 2048



//******************************************************************************
//		Include
//******************************************************************************
#include <sstream> // Head file for stringstream
#include <fstream> // Head file for filestream
#include <algorithm>
#include <iostream>

#include "Image.h"

//Constructor
//------------------
Image::Image():
//------------------
	m_width(0),
	m_height(0),
	m_p_image(0)
//------------------
{ // NOTHING TO DO HERE
}

//Copy constructor
//-------------------------------
Image::Image(const Image& anImage):
//-------------------------------
				m_width(anImage.m_width),
                        m_height(anImage.m_height),
                        m_p_image(new float[m_height*m_width])
//--------------------------------
{
            // IT IS THE CONSTRUCTOR, USE AN INITIALISATION LIST
            // Copies data from one float array to another float array
            std::memcpy(m_p_image, anImage.m_p_image, (m_height*m_width*sizeof(float)));

}

//Destructor
//-------------
Image::~Image()
//-------------
{
            delete[] m_p_image;
   // ADD CODE HERE TO RELEASE THE MEMORY
}

//Destructor
//-------------------
void Image::destroy()
//-------------------
{
   // Memory has been dynamically allocated
   if (m_p_image)
   {
      // Release the memory
      delete [] m_p_image;

      // Make sure the pointer is reset to NULL
```

```
        m_p_image = 0;
    }

    // There is no pixel in the image
    m_width  = 0;
    m_height = 0;
}

//Copies the data of an image
//------------------------------------------
Image& Image::operator=(const Image& anImage)
//------------------------------------------
{
            // CODE HERE TO COPY THE DATA
            destroy();

            m_width = anImage.m_width;
            m_height = anImage.m_height;
            m_p_image = new float[m_height*m_width];
            std::memcpy(m_p_image, anImage.m_p_image, (m_height*m_width*sizeof(float)));
            return *(this);
}

//Adds two images to each other and returns resulting image
//-----------------------------------------
Image Image::operator+(const Image& anImage)
//-----------------------------------------
{
            Image tempImage;

            // if original image is smaller than added image
    if (m_width < anImage.m_width) {
        //std::cout << "added image bigger" << std::endl;
        tempImage.m_width = m_width;
        tempImage.m_height = m_height;
        tempImage.m_p_image = new float[m_width*m_height];

        //copy smaller image into temp
        std::memcpy(tempImage.m_p_image, m_p_image, (m_width*m_height *
sizeof(float)));

        //itereate over each pixel up to size of smaller image
        for (unsigned int j = 0; j < m_height; ++j) {
            for (unsigned int i = 0; i < m_width; ++i) {
                //add to values in master image' i,j, the values at anImage's i,j and
store in temp
                tempImage.m_p_image[j * m_width + i] = m_p_image[j * m_width +
i] + anImage.m_p_image[j * anImage.m_width + i];
            }
        }

    }
    else { //if subtracted image equal or smaller

        //std::cout << "added image smaller or equal" << std::endl;
        tempImage.m_width = anImage.m_width;
        tempImage.m_height = anImage.m_height;
        tempImage.m_p_image = new float[anImage.m_width*anImage.m_height];
        //copy image pixel by pixel

        //copy original image into temporary image
        std::memcpy(tempImage.m_p_image, anImage.m_p_image,
(anImage.m_width*anImage.m_height * sizeof(float)));
```

```
        for (unsigned int j = 0; j < anImage.m_height; ++j) {

            for (unsigned int i = 0; i < anImage.m_width; ++i) {

                //still some issues here

                tempImage.m_p_image[j* anImage.m_width + i] = m_p_image[j *
m_width + i] + anImage.m_p_image[j* anImage.m_width + i];

                //use couts

            }

        }

    }

    return tempImage;

}



//SUBTRACTS TWO IMAGES FROM EACH OTHER AND RETURNS RESULTING IMAGE

//------------------------------------------

Image Image::operator-(const Image& anImage)

//------------------------------------------

{

    Image tempImage;


    // if original image is smaller than added image

    if (m_width < anImage.m_width) {

        std::cout << "subtracted image bigger" << std::endl;

        tempImage.m_width = m_width;

        tempImage.m_height = m_height;

        tempImage.m_p_image = new float[m_width*m_height];


        //copy smaller image into temp

        std::memcpy(tempImage.m_p_image, m_p_image,
(m_width*m_height*sizeof(float)));


        //itereate over each pixel up to size of smaller image
        for (unsigned int j = 0; j < m_height; ++j) {
            for (unsigned int i = 0; i < m_width; ++i) {
                //add to values in master image' i,j, the values at anImage's i,j and
store in temp
                tempImage.m_p_image[j * m_width + i] = m_p_image[j * m_width +
i] - anImage.m_p_image[j * anImage.m_width + i];
            }
        }

    }
    else { //if subtracted image equal or smaller
        std::cout << "subtracted image smaller or equal" << std::endl;
        tempImage.m_width = anImage.m_width;
        tempImage.m_height = anImage.m_height;
        tempImage.m_p_image = new float[anImage.m_width*anImage.m_height];
        //copy image pixel by pixel

        //copy original image into temporary image
        std::memcpy(tempImage.m_p_image, anImage.m_p_image,
(anImage.m_width*anImage.m_height*sizeof(float)));

        for (unsigned int j = 0; j < anImage.m_height; ++j) {
            for (unsigned int i = 0; i < anImage.m_width; ++i) {
                tempImage.m_p_image[j* anImage.m_width + i] = m_p_image[j *
m_width + i] - anImage.m_p_image[j* anImage.m_width + i];
            }
        }
    }
    return tempImage;
}

//Adds two images and returns a reference to the created image
```

```
//--------------------------------------------
Image& Image::operator+=(const Image& anImage)
//--------------------------------------------
{
    unsigned int imageWidth, imageHeight;
    //if anImage is bigger than original image
    if (m_width < anImage.m_width || m_height < anImage.m_height) {

        //set image width and height of smaller image original
        imageWidth = m_width;
        imageHeight = m_height;
    } else { //if anImage is smaller or of equal size than original image

        //set image width and height of added image
        imageWidth = anImage.m_width;
        imageHeight = anImage.m_height;
    }

    //iterate rows and columns of pixel array
    for (unsigned int j = 0; j < imageHeight; ++j) {
        for (unsigned int i = 0; i < imageWidth; ++i) {

            //add pixels from anImage to image and store in the image
            m_p_image[j* m_width + i] = m_p_image[j * m_width + i] +
anImage.m_p_image[j* anImage.m_width + i];
        }
    }
    //return the reference
    return *(this);
}
```

```
//Subtracts two images and returns a reference to the image.

//-------------------------------------------

Image& Image::operator-=(const Image& anImage)

//-------------------------------------------

{

    unsigned int imageWidth, imageHeight;

    //set image width and height of smaller image original

    if (m_width < anImage.m_width || m_height < anImage.m_height) {

        //set image width and height to that of original image

        imageWidth = m_width;

        imageHeight = m_height;

    }

    else { //if anImage is smaller or of equal size than original image

         //set image width and height of added image

            imageWidth = anImage.m_width;

            imageHeight = anImage.m_height;

    }

    //iterate rows and columns of pixel array

    for (unsigned int j = 0; j < imageHeight; ++j) {

        for (unsigned int i = 0; i < imageWidth; ++i) {

            //subtract pixels from anImage to image and store in the image

            m_p_image[j* m_width + i] = m_p_image[j * m_width + i] -
anImage.m_p_image[j* anImage.m_width + i];

        }

    }

    //return the reference

    return *(this);

}


//Adds aValue to each pixel of the current image.

//---------------------------------
```

```
Image Image::operator+(float aValue)
//---------------------------------
{
	unsigned int pixelsInImage(m_height*m_width);
	Image tempImage;
	tempImage.m_height = m_height;
	tempImage.m_width = m_width;
	tempImage.m_p_image = new float[pixelsInImage];

	//iterate through pixel array
	for (unsigned int i = 0; i < pixelsInImage; ++i) {
		//add value to each value already in array and store at in new image
		tempImage.m_p_image[i] = m_p_image[i] + aValue;
	}
	//returns the new image
	return tempImage;
}

//Subtracts avalue from each pixel of the current image.
//---------------------------------
Image Image::operator-(float aValue)
//---------------------------------
{
	unsigned int pixelsInImage(m_height*m_width);
	Image tempImage;
	tempImage.m_height = m_height;
	tempImage.m_width = m_width;
	tempImage.m_p_image = new float[pixelsInImage];

	//iterate through pixel array
	for (unsigned int i = 0; i < pixelsInImage; ++i) {
			//subtracts a value from each value in the original imge and store at in new image
			tempImage.m_p_image[i] = m_p_image[i] - aValue;
		}
		//return the new iamge
		return tempImage;
}

//Multiplies each pixel in image by aValue
//----------------------------------
Image Image::operator*(float aValue)
//----------------------------------
{
		unsigned int pixelsInImage(m_height*m_width);
		Image tempImage; //(new float[pixelsInImage]);
		tempImage.m_height = m_height;
		tempImage.m_width = m_width;
		tempImage.m_p_image = new float[pixelsInImage];

		//iterate through pixel array
		for (unsigned int i = 0; i < pixelsInImage; ++i) {
			//multiplies each value in the original with a floating point value and stores it in a 
new image
			tempImage.m_p_image[i] = m_p_image[i] * aValue;
		}
		//returns the new image
		return tempImage;
}

//Divides each pixel by aValue and returns resulting image
//----------------------------------
Image Image::operator/(float aValue)
```

```
//----------------------------------
{
   // ADD CODE HERE TO DIVIDE EACH PIXEL OF THE CURRENT IMAGE BY aValue,
   // AND RETURN THE RESULTING IMAGE
        unsigned int pixelsInImage(m_height*m_width);
        Image tempImage;
        tempImage.m_height = m_height;
        tempImage.m_width = m_width;
        tempImage.m_p_image = new float[pixelsInImage];

        for (unsigned int i = 0; i < pixelsInImage; ++i) {
                tempImage.m_p_image[i] = m_p_image[i] / aValue;
        }
        return tempImage;
}

//Arithmetic assignment operator for addition
//-----------------------------------
Image& Image::operator+=(float aValue)
//-----------------------------------
{
        unsigned int pixelsInImage(m_height*m_width);

        //iterates through the pixel array and adds a value to each pixel
        for (unsigned int i = 0; i < pixelsInImage; ++i) {
                m_p_image[i] = m_p_image[i] + aValue;
        }
        //returns the current image
        return *(this);
}
```

```
//Assignment operator for subtraction

//-----------------------------------

Image& Image::operator-=(float aValue)

//-----------------------------------

{

	unsigned int pixelsInImage(m_height*m_width);


	//iterates through each pixel in the array and subtracts a value from it

	for (unsigned int i = 0; i < pixelsInImage; ++i) {

		m_p_image[i] = m_p_image[i] - aValue;

	}

	//returns a reference ot the image

	return *(this);

}


//Assignment operator for multiplication

//-----------------------------------

Image& Image::operator*=(float aValue)

//-----------------------------------

{

	unsigned int pixelsInImage(m_height*m_width);


	//iterates through each pixel in the array and multiplies it with a value

	for (unsigned int i = 0; i < pixelsInImage; ++i) {

		m_p_image[i] = m_p_image[i] * aValue;

	}

	return *(this);

}


//Assignment operator for division

//-----------------------------------
```

```
Image& Image::operator/=(float aValue)
//-----------------------------------
{
        unsigned int pixelsInImage(m_height*m_width);

        //iterates through each pixel in the array and divides it by a value
        for (unsigned int i = 0; i < pixelsInImage; ++i) {
                m_p_image[i] = m_p_image[i] / aValue;
        }
        return *(this);
}

//Implementation of negation operator
//----------------------
Image Image::operator!()
//----------------------
{
        unsigned int pixelsInImage(m_height*m_width);
        const int MAX_COLOR = 255;
        Image tempImage;
        tempImage.m_height = m_height;
        tempImage.m_width = m_width;
        tempImage.m_p_image = new float[pixelsInImage];

        //iterates through each pixel in the array and inverts its
        for (unsigned int i = 0; i < pixelsInImage; ++i) {
                tempImage.m_p_image[i] = MAX_COLOR - m_p_image[i];
        }
        return tempImage;
}
```

```
//Sets pixel value

//-----------------------------

void Image::setPixel(unsigned int i, unsigned int j, float aValue)

//-----------------------------

{

	m_p_image[j * m_width + i] = aValue;

}


//Gets pixel value

//-----------------------------

float Image::getPixel(unsigned int i, unsigned int j) const

{

	return m_p_image[j * m_width + i];

}

//-----------------------------


//Returns max value

//-----------------------------

float Image::getMaxValue() const

//-----------------------------

{

   return (*std::max_element(&m_p_image[0], &m_p_image[m_width * m_height]));

}


//Returns height

//-----------------------------

unsigned int Image::getHeight() const

//-----------------------------

{

	return m_height;

}
```

```
//Returns width
//-----------------------------
unsigned int Image::getWidth() const
//-----------------------------
{
        return m_width;
}

//Displays the aspect ratio
//-----------------------------
float Image::getAspectRatio()
{
        float image_ratio = ((float)m_width / (float)m_height);
        return image_ratio;
}



//-------------------------------------------------------------
void Image::shiftScaleFilter(float aShiftValue, float aScaleValue)
//-------------------------------------------------------------
{
  // Process every pixel of the image
  for (unsigned int i = 0; i < m_width * m_height; ++i)
  {
    // Apply the shilft/scale filter
    m_p_image[i] = (m_p_image[i] + aShiftValue) * aScaleValue;
  }
}
```

```
//--------------------------------------
void Image::loadPGM(const char* aFileName)
//--------------------------------------
{
    // Open the file
    std::ifstream input_file(aFileName, std::ifstream::binary);

    // The file does not exist
    if (!input_file.is_open())
    {
        // Build the error message
        std::stringstream error_message;
        error_message << "Cannot open the file \"" << aFileName << "\". It does not exist";

        // Throw an error
        throw (error_message.str());
    }
    // The file is open
    else
    {
        // Release the memory if necessary
        destroy();

        // Variable to store a line
        char p_line_data[LINE_SIZE];

        // Get the first line
        input_file.getline(p_line_data, LINE_SIZE);

        // Get the image type
        std::string image_type(p_line_data);
```

```
// Valid ASCII format
if (image_type == "P2")
{
  // Variable to save the max value
  int max_value(-1);

  // There is data to read
  unsigned int pixel_count(0);
  while (input_file.good())
  {
    // Get the new line
    input_file.getline(p_line_data, LINE_SIZE);

    // It is not a comment
    if (p_line_data[0] != '#')
    {
      // Store the line in a stream
      std::stringstream stream_line;
      stream_line << std::string(p_line_data);

      // The memory is not allocated
      if (!m_p_image && !m_width && !m_height)
      {
        // Load the image size
        stream_line >> m_width >> m_height;

        // Alocate the memory
        m_p_image = new float[m_width * m_height];

        // Out of memory
```

```
                if (!m_p_image)
                {
                    throw ("Out of memory");
                }
            }
            // The max value is not set
            else if (max_value < 0)
            {
                // Get the max value;
                stream_line >> max_value;
            }
            // Read the pixel data
            else
            {
                // Process all the pixels of the line
                while (stream_line.good())
                {
                    // Get the pixel value
                    int pixel_value(-1);
                    stream_line >> pixel_value;
                    // The pixel exists
                    if (pixel_count < m_width * m_height)
                    {
                        m_p_image[pixel_count++] = pixel_value;
                    }
                }
            }
        }
    }
}
// Valid binary format
```

```
else if (image_type == "P5")
{
  // Variable to save the max value
  int max_value(-1);

  // There is data to read
  unsigned int pixel_count(0);
  while (input_file.good() && !pixel_count)
  {
   // Process as an ASCII file
    if (!m_width || !m_height || max_value < 0)
    {
      // Get the new line
      input_file.getline(p_line_data, LINE_SIZE);

      // It is not a comment
      if (p_line_data[0] != '#')
      {
        // Store the line in a stream
        std::stringstream stream_line;
        stream_line << std::string(p_line_data);

        // The memory is not allocated
        if (!m_p_image && !m_width && !m_height)
        {
          // Load the image size
          stream_line >> m_width >> m_height;

          // Allocate the memory
          m_p_image = new float[m_width * m_height];
```

```
         // Out of memory
         if (!m_p_image)
         {
            throw ("Out of memory");
         }
      }
      // The max value is not set
      else
      {
         // Get the max value;
         stream_line >> max_value;
      }
   }
}
// Read the pixel data
else
{
          unsigned char* p_temp(new unsigned char[m_width * m_height]);

   // Out of memory
   if (!p_temp)
   {
      throw ("Out of memory");
   }

   input_file.read(reinterpret_cast<char*>(p_temp), m_width * m_height);

          for (unsigned int i(0); i < m_width * m_height; ++i)
          {
                                                     ++pixel_count;
                     m_p_image[i] = p_temp[i];
```

```
              }
              delete [] p_temp;
        }
      }
    }
    // Invalid format
    else
    {
      // Build the error message
      std::stringstream error_message;
      error_message << "Invalid file (\"" << aFileName << "\")";

      // Throw an error
      throw (error_message.str());
    }
  }
}


//----------------------------------------------
void Image::loadPGM(const std::string& aFileName)
//----------------------------------------------
{
  loadPGM(aFileName.data());
}


//---------------------------------------
void Image::savePGM(const char* aFileName)
//---------------------------------------
{
```

```
// Open the file
std::ofstream output_file(aFileName);

// The file does not exist
if (!output_file.is_open())
{
   // Build the error message
   std::stringstream error_message;
   error_message << "Cannot create the file \"" << aFileName << "\"";

   // Throw an error
   throw (error_message.str());
}
// The file is open
else
{
   // Set the image type
   output_file << "P2" << std::endl;

   // Print a comment
   output_file << "# ICP3038 -- Assignment 1 -- 2015/2016" << std::endl;

   // The image size
   output_file << m_width << " " << m_height << std::endl;

   // The get the max value
   output_file << std::min(255, std::max(0, int(getMaxValue()))) << std::endl;

   // Process every line
   for (unsigned int j = 0; j < m_height; ++j)
   {
         // Process every column
         for (unsigned int i = 0; i < m_width; ++i)
         {
            // Process the pixel
            int pixel_value(m_p_image[j * m_width + i]);
            pixel_value = std::max(0, pixel_value);
            pixel_value = std::min(255, pixel_value);

            output_file << pixel_value;

            // It is not the last pixel of the line
            if (i < (m_width - 1))
            {
               output_file << " ";
            }
         }

         // It is not the last line of the image
         if (j < (m_height - 1))
         {
            output_file << std::endl;
         }
      }
   }
}


//----------------------------------------------
void Image::savePGM(const std::string& aFileName)
//----------------------------------------------
{
  savePGM(aFileName.data());

}
```

```
/**
********************************************************************************
*
*      @file         test.cpp
*
*      @brief        TESTER FOR IMAGE CLASS
*
*      @version      1.0
*
*      @date         25/10/2016
*
*      @author              Dorian B. Dressler (eeu436@bangor@ac.uk)
*
*
********************************************************************************
*/


//******************************************************************************
//     Include
//******************************************************************************
#include <sstream>
#include <iostream>
#include <exception>

#include "Image.h"


//-----------------------------
int main(int argc, char** argv)
//-----------------------------
{
    // Return code
    int error_code(0);

    // Catch exceptions
    try
    {
        // Good number of arguments
        if (argc == 3)//prev 3
        {
            // Load an image
            Image test_image;
                     Image test_image2;
                     //Image test_image2;
            test_image.loadPGM(argv[1]);
                     //test_image2.loadPGM(argv[2]);
                     // Save the image
                     char* fileName = (argv[2]);
            //test_image.savePGM(argv[3]);

                     Image test_image3;
                     std::cout << test_image.getAspectRatio() << std::endl;
                     //std::cout << test_image.getHeight() << std::endl;
                     //std::cout << test_image.getWidth() << std::endl;
                     //std::cout << test_image.getPixel(25, 25) << std::endl;
```

```
                    //test_image.setPixel(25, 25, 125);
                    //test_image.savePGM(fileName);
                    //std::cout << test_image.getPixel(25, 25) << std::endl;

                    //std::cout << test_image.getAspectRatio() << std::endl;
                    //test_image3 = test_image / (2.5);
                    //test_image3.savePGM(fileName);
                    //(!(test_image)).savePGM(fileName);
                    //test_image3.savePGM(fileName);
                    //(!(test_image)).savePGM("test.pgm");
                    //Create second image to perform tests on
                    //Image test_image3(test_image);

                    /*std::cout << test_image3.getPixel(25, 25) << std::endl;
                    test_image3.setPixel(25, 25, 100);
                    std::cout << test_image3.getPixel(25, 25) << std::endl;
                    test_image3.savePGM("Result.pgm");*/
                    //(test_image -= (test_image2)).savePGM("Result.pgm");
                    //(!(test_image)).savePGM("result.pgm");
                    //test_image2 = test_image + (100.0);
                    //test_image3.savePGM("ResultThree.pgm");

                    //Image test_image3;
                    //test_image3 = test_image+(test_image2);
                    //test_image3.savePGM("result.pgm");
                    //----------------------
                    //testing plus operator again
                    //test_image3 = test_image / (100.0);
                    //test_image3 = test_image /= (50.0);
                    //-----------------------
                    //testing + operator
                    //test_img2 = test_image + (100);
                    //test_img2.savePGM("+operator_test.pgm");
                    //(!(test_image)).savePGM("result.pgm");
                    //test_image3.savePGM("result.pgm");

                    //Image test_img3;
                    //test_img2 = test_image - (100);
                    //test_img3 = test_img2 -= (test_image);
                    //Image = test_image += (test_image);
                    //test_img2 -= (100);

                    //-------------------------
                    //Testing ! operator
                    //(!test_image).savePGM("test3.pgm");
                    //test_img2 = !(test_image);
                    //test_img2.savePGM("test4.pgm");


        }
        // Wrong number of argument
        else
        {
            // Build the error message
            std::stringstream error_message;
            error_message << "Wrong number of arguments, usage:" << std::endl;
            error_message << "\t" << argv[0] << " input_file_name.pgm 
output_file_name.pgm" << std::endl;

            // Throw the error
            throw (error_message.str());
        }
```

```
    }
    // An error occured
    catch (const std::exception& error)
    {
        error_code = 1;
        std::cerr << error.what() << std::endl;
    }
    catch (const std::string& error)
    {
        error_code = 1;
        std::cerr << error << std::endl;
    }
    catch (const char* error)
    {
        error_code = 1;
        std::cerr << error << std::endl;
    }
    catch (...)
    {
        error_code = 1;
        std::cerr << "Unknown error" << std::endl;
    }

    return (error_code);
}
```