



FALMOUTH  
UNIVERSITY

COMP120: Creative Computing  
**3: Tinkering Graphics II**



# Learning Outcomes

- ▶ **Explain how** conditional logic can manipulate the output of a computer program
- ▶ **Apply** mathematical knowledge to **write** computer programs that manipulate pixels in a surface
- ▶ **Trace** existing computer programs

# House Keeping

This week we are going to focus on workflow. Less hacky more professional:

- ▶ Make sure in your pair you have a shared repo on **Bitbucket**
- ▶ We will try to focus on portable code that uses **constants** over **literals**
- ▶ Reuse **functions** to build an effective code base.
- ▶ Link your functions to the Forms **UI** components

# Recap - Functions in C#

```
public static string NameAndScore(string Name, int Score)
{
    string combine = "Name: " + Name + " Score: " + Score;
    return combine;
}
string output = NameAndScore("Matt", 2345);
Console.WriteLine(output);
```

Console Output:

```
Name: Matt Score: 2345
```

Applied to a BMP specific function:

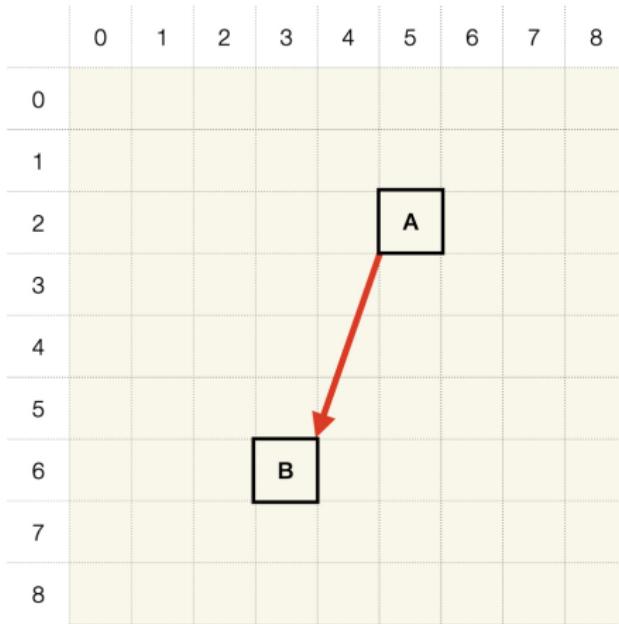
```
public static bitmap GreyScale(string Image)
{
    //Code to tinker your graphic
    return;
}
```

# Distance Between Colors

Sometimes we need to measure when something is 'close enough':

- ▶ Distance between two points in the Cartesian coordinate system:
- ▶  $\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$
- ▶ Distance between two colours in the RGB colour representation system:
- ▶  $\sqrt{(red_1 - red_2)^2 + (green_1 - green_2)^2 + (blue_1 - blue_2)^2}$

## Distance between 2 points



Using the Cartesian coordinate system:

$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

$$\text{Pos A} = 5, 2$$

$$\text{Pos B} = 3, 6$$

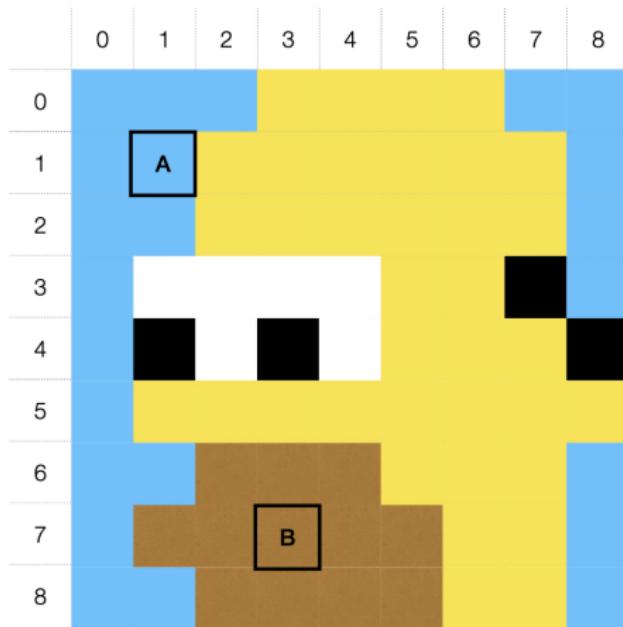
$$d = \sqrt{(3 - 5)^2 + (6 - 2)^2}$$

$$d = \sqrt{(-2)^2 + (4)^2}$$

$$d = \sqrt{20}$$

$$d = 4.472136$$

## Distance between 2 colours



In the **RGB** representation system:

$$\sqrt{(red_1 - red_2)^2 + (green_1 - green_2)^2 + (blue_1 - blue_2)^2}$$

Colour A = **86,193,255**

Colour B = **172,118,49**

$$d = \sqrt{(86 - 172)^2 + (193 - 118)^2 + (255 - 49)^2}$$

$$d = \sqrt{(-86)^2 + (75)^2 + (206)^2}$$

$$d = \sqrt{55457}$$

$$d = \mathbf{235.4930}$$

# Activity #1: Color Distance

In pairs:

- ▶ Setup a basic project in Visual Studio
- ▶ Use the distance equation from the previous slide to write a function which accepts two colours and returns the distance
- ▶ Test your solution
- ▶ Then, post your solution on Slack

# Numeric Return Values

```
public static int GetDistance(Color first, Color second)
{
    int redDifference;
    int greenDifference;
    int blueDifference;
    double sqrt;

    redDifference = first.R - second.R;
    greenDifference = first.G - second.G;
    blueDifference = first.B - second.B;
    sqrt = Math.Sqrt(redDifference * redDifference +
                     greenDifference * greenDifference +
                     blueDifference * blueDifference);

    return sqrt;
}
```

# Expected Output: Color Distance

You can use predefined color names with this method:

```
Color Color1 = Color.FromKnownColor(KnownColor.Pink);
```

Expected Values:

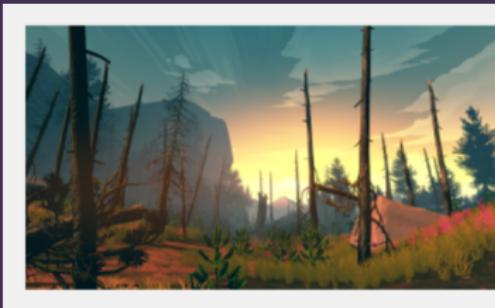
```
Console.WriteLine (GetDistance(WHITE, BLACK));
OUTPUT - "441.6729"
Console.WriteLine (GetDistance(WHITE, PINK));
OUTPUT - "81.6884"
Console.WriteLine (GetDistance(BLACK, PINK));
OUTPUT - "378.2829"
Console.WriteLine (GetDistance(MAGENTA DARKGOLDENROD));
OUTPUT - "287.2855"
```

NOTE - You need to create the color objects and pass them into the function, don't just use a colour in capitals. just for illustration.

# Activity #2: Colour Tolerance

In pairs:

- ▶ Setup a Windows forms project in Visual Studio
- ▶ Implement the function `closeEnough( colour1, colour2, tolerance)` that returns a boolean value
- ▶ Test your solution
- ▶ Then, post your solution on Slack



# Boolean Return Values

```
public static bool closeEnough(Color first, Color second,  
int tolerance) {  
    int redDifference;  
    int greenDifference;  
    int blueDifference;  
    redDifference = first.R - second.R;  
    greenDifference = first.G - second.G;  
    blueDifference = first.B - second.B;  
    if ((redDifference * redDifference + greenDifference  
        * greenDifference + blueDifference * blueDifference)  
        < tolerance) {  
        return true;  
    } else {  
        return false;  
    }  
}
```

Note: This source code should be used in conjunction with a function call to activate it.

# Tolerance-based Pixel Manipulation

```
public static bool turnRed(Color newColour) {
    Color brown = Color.FromKnownColor(KnownColor.Brown);
    int redDifference;
    int greenDifference;
    int blueDifference;
    double sqrt;
    redDifference = newColour.R - brown.R;
    greenDifference = newColour.G - brown.G;
    blueDifference = newColour.B - brown.B;
    sqrt = Math.Sqrt(redDifference * redDifference +
        greenDifference * greenDifference + blueDifference *
        blueDifference);

    if (sqrt < 80) {
        return true;
    } else {
        return false;
    }
}
```

# Tolerance-based Pixel Manipulation

```
Color p;

for (int y = 0; y < height; y++) {
    for (int x = 0; x < width; x++) {
        p = bmp.GetPixel(x, y);
        if (turnRed(p)) {
            bmp.SetPixel(x, y, Color.FromKnownColor
                (KnownColor.Red));
        }
    }
}
```

Note: This uses the function from the previous screen. To achieve the outcome that you want you may need to tinker with the tolerance level to quite a high number.

# Red Eye

- ▶ When the flash of the camera catches the eye just right (especially with light colored eyes), we get bounce back from the back of the retina.
- ▶ This results in ‘red eye’
- ▶ We can replace the “red” with a color of our choosing
- ▶ First, we figure out where the eyes are (x,y)



C:\Documents and Settings\Mark Guz...



## Zoom

X: 109 Y: 91 R: 129 G: 97 B: 76



# Activity #3: Red Eye

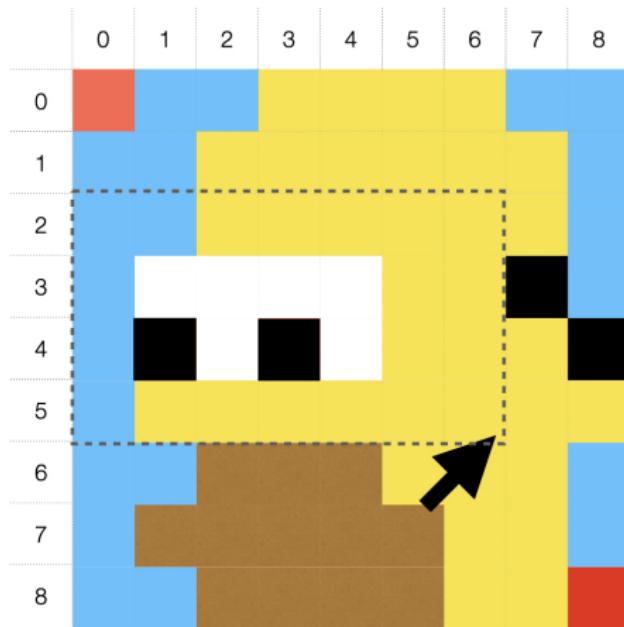
In pairs:

- ▶ Setup a Windows form project in Visual Studio
- ▶ You will need to create a method to sample a specific area of the image. I suggest you sample the mouse position.

```
private void pictureBox1_MouseUp(object sender,  
MouseEventArgs e)  
{  
    mouseX = e.X;  
    mouseY = e.Y;  
}
```

- ▶ Implement the function: removeRedEye(picture, area, colour)
- ▶ Test your solution
- ▶ Then, post your solution on Teams

Create a sampling area using the mouse



Top Left: **0,2**

Bottom Right: **6,5**



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## Zoom

X: 183 Y: 97 R: 0 G: 0 B: 0



# Posterization

- ▶ Posterization is simply reducing the number of colours in an image
- ▶ We look for a range of colours, then map them to a single colour, e.g:
  - ▶ If red is between 63 and 128, set it to 95
  - ▶ If green is less than 64, set it to 31
- ▶ The end result is that a bunch of different colours, get set to a few colours
- ▶ Beware of naive solutions with a large number of 'if' statements

Zoom

X: 0 Y: 0

R: 155 G: 153 B: 94 Color at location:



Zoom

X: 0 Y: 0

R: 159 G: 159 B: 95 Color at location:



# Calculating Luminance in RGB

To do this, we may need to determine the luminance of a pixel:

- ▶ Luminance is the overall brightness of a pixel
- ▶ In RGB, it is the *mean* average value of each component:
  - ▶  $lum = (red + green + blue)/3$

# Activity #5: Black and White

In pairs:

- ▶ Setup a Windows form project in Visual Studio
- ▶ Refer to the following documentation
- ▶ Implement the function: `makeGreyscale(picture, colourCount)`
- ▶ Test your solution
- ▶ Then, post your solution on Slack

# Source Code: Black and White

```
for (int y = 0; y < height; y++) {
    for (int x = 0; x < width; x++) {
        p = bmp.GetPixel(x, y);
        int r = p.R;
        int g = p.G;
        int b = p.B;
        int luminance = (r + g + b) / 3;
        // start at 64 to see the difference
        if (luminance < 104)      {
            bmp.SetPixel(x, y, Color.FromArgb(255, 0, 0,
                0));
        }
        if (luminance >= 104)     {
            bmp.SetPixel(x, y, Color.FromArgb(255, 255,
                255, 255));
        }
    }
}
```

# Sepia Tone

- ▶ Pictures that are sepia-toned have a yellowish tint to them that we associate with older pictures.
- ▶ It's not directly a matter of simply increasing the yellow in the picture, because it's not a one-to-one correspondence:
  - ▶ Instead, colors in different ranges get mapped to other colours.
  - ▶ We can create such a mapping using IF statements
- ▶ The end result is that a bunch of different colours, get set to a few colours
- ▶ Beware of naive solutions with a large number of 'if' statements





# Sepia Tone

- ▶ First, we're calling greyScaleNew (the one with weights).
- ▶ We then manipulate the red (increasing) and the blue (decreasing) channels to bring out more yellows and oranges.
  - ▶ It's perfectly okay to have one function calling another.
  - ▶ Why are we doing the comparisons on the red? Why not? After greyscale conversion, all channels are the same!
- ▶ The end result is that a bunch of different colours, get set to a few colours
- ▶ Why these values? Trial-and-error: Tinker the values!

# Source Code: Sepia (1)

```
public void sepiaTint(picture) {
    //Convert image to greyscale
    makeGreyscale(picture);
    for (int y = 0; y < height; y++)
    {
        for (int x = 0; x < width; x++)
        {
            p = picture.GetPixel(x, y);

            int r = p.R;
            int g = p.G;
            int b = p.B;

            if (r < 63)
            {
                r = r*1.1;
                b = b*0.9;
            }
            ...
        }
    }
}
```

# Source Code: Sepia (2)

```
...
    if (r > 62 and r < 192) {
        bmp.SetPixel(x, y, Color.FromArgb(
            255, 255, 255, 255));
    }
    if (r > 191) {
        r = r*1.08;
        if (r > 255) {
            r = 255;
        }
        b = b*0.93;
    }
}
}
```

Note: This requires that you incorporate a greyscale function as well.

# Activity #6: Sepia Tone

In pairs:

- ▶ Setup a Windows form project in Visual Studio
- ▶ Refer to the following documentation
- ▶ Refactor the function: `sepiaTint(picture)` to use constants rather than literals
- ▶ Tinker with the values of the constants to test your solution
- ▶ Then, post your solution on Teams