



COMP120: Creative Computing: Tinkering

5: 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 to **predict** its output for a given input

Code Tracing



Live Demonstration

- ▶ Start using debug tools when you run into problems:
- ▶ <https://www.youtube.com/watch?v=QJtWxm12Eo0>

Source Code: Less Red

```
def decreaseRed(picture, amount):  
    pixelMatrix = getPixels(picture)  
    for pixel in pixelMatrix:  
        value = getRed(pixel)  
        setRedPixel(pixel, value * amount)
```

Note: This source code excerpt will not work in PyGame.



Activity: Less Red

If 'bb' is the original picture of Big Ben, which of the below function calls created the change:

- ▶ `changeRed(bb, 1.5)`
- ▶ `changeRed(bb, 2.0)`
- ▶ `changeRed(bb, 0)`

Tinkering Graphics Activities



Calculating 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:

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

Activity: Color Distance

In pairs:

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

Output: Color Distance

```
>>> print distance(WHITE, BLACK)
441.6729559300637
>>> print distance(WHITE, PINK)
113.13708498984761
>>> print distance(BLACK, PINK)
355.3519382246282
>>> print distance(MAGENTA, PINK)
192.41881404893857
```

Source Code: Conditions and Return Values

```
def closeEnoughToBrown(colour):  
    if distance(colour, BROWN) < 50.0:  
        return True  
    else:  
        return False
```

Note: This source code excerpt will not work in PyGame.

Source Code: Conditional Tolerance

```
def turnRed():  
    brown = makeColor(42,25,15)  
    file="/Users/guzdial/Desktop/mediasources/katieFancy ←  
        .jpg"  
    picture=loadPicture(file)  
    for pixel in getPixels(picture):  
        color = getColor(pixel)  
        if distance(color, BROWN) < 50.0:  
            red=getRed(pixel)*2  
            green=getGreen(pixel)  
            blue=getBlue(pixel)  
            setColor(pixel,makeColor(red,green,blue))  
    return picture
```

Note: This source code excerpt will not work in PyGame.

Activity: Colour Tolerance

In pairs:

- ▶ Setup a basic project in PyGame
- ▶ Implement the function `closeEnough ((colour, colour), tolerance)` that returns a boolean value
- ▶ Test your solution
- ▶ Then, post your solution on Slack
- ▶ 10 minutes

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)



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Zoom

X: 109

Y: 91

R: 129

G: 97

B: 76



Activity: Red Eye

In pairs:

- ▶ Setup a basic project in PyGame
- ▶ Refer to the following documentation
 - ▶ <http://www.pygame.org/docs/ref/rect.html>
- ▶ Implement the function: `removeRedEye (picture, area, colour)`
- ▶ Test your solution
- ▶ Then, post your solution on Slack
- ▶ 20 minutes



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Zoom

X: 183

Y: 97

R: 0

G: 0

B: 0

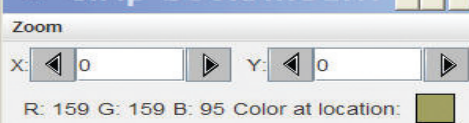
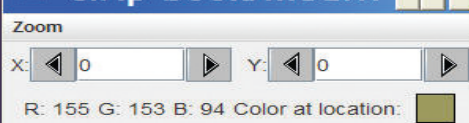


Calculating Luminance in RGB

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

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:
 - ▶ 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



Source Code: Black and White

```
def blackAndWhitePosterize(picture):  
    for pixel in getPixels(picture):  
        red = getRed(pixel)  
        green = getGreen(pixel)  
        blue = getBlue(pixel)  
        luminance = (red + green + blue) / 3  
        if luminance < 64:  
            setColor(pixel, BLACK)  
        else:  
            setColor(pixel, WHITE)
```

Note: This source code excerpt will not work in PyGame.

Activity: Posterization

In pairs:

- ▶ Setup a basic project in PyGame
- ▶ Refer to the following documentation
- ▶ Implement the function: `makeGreyscale (picture, colourCount)`
- ▶ Test your solution
- ▶ Then, post your solution on Slack
- ▶ 20 minutes

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





Source Code: Sepia (1)

```
def sepiaTint (picture):  
    #Convert image to greyscale  
    makeGreyscale (picture)  
  
    #loop through picture to tint pixels  
    for p in getPixels (picture):  
        red = getRed (p)  
        blue = getBlue (p)  
  
        #tint shadows  
        if (red < 63):  
            red = red*1.1  
            blue = blue*0.9  
  
    ...
```

Note: This source code excerpt will not work in PyGame.

Source Code: Sepia (2)

```
...  
#tint midtones  
if (red > 62 and red < 192):  
    red = red*1.15  
    blue = blue*0.85  
  
#tint highlights  
if (red > 191):  
    red = red*1.08  
    if (red > 255):  
        red = 255  
  
    blue = blue*0.93  
  
#set the new color values  
setBlue(p, blue)  
setRed(p, red)
```

Note: This source code excerpt will not work in PyGame.

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!

Activity: Sepia Tone

In pairs:

- ▶ Setup a basic project in PyGame
- ▶ 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 Slack
- ▶ 20 minutes

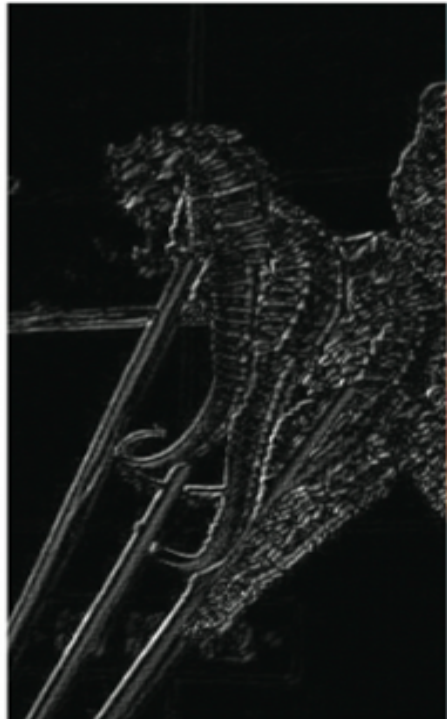
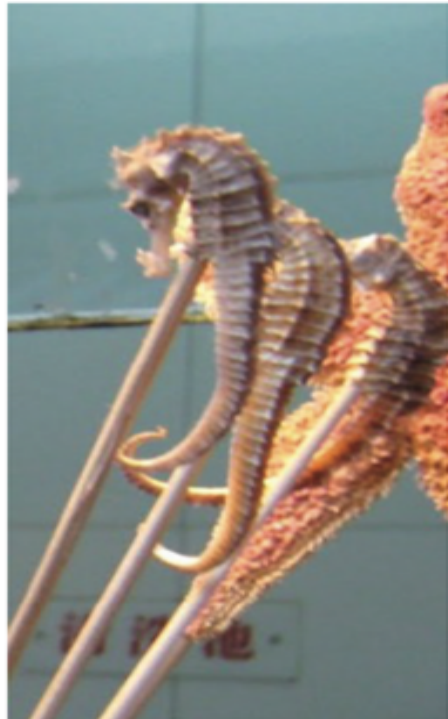
Edge Detection

- ▶ Blurring is averaging across pixels
- ▶ Edge detection is looking for *differences* between pixels:
 - ▶ We draw lines that our eyes see — where the luminance changes
- ▶ If the pixel changes left-to-right, or up-and-down, make a pixel black. Else, white.

Source Code: Edge Detection

```
def drawEdges (picture):  
    for x in xrange(0, picture.length - 1):  
        for y in xrange(0, picture.height - 1):  
            pixelSum = getRed(pixel) + getGreen(pixel) + ↵  
                        getBlue(pixel)  
            nextPixel = getPixel(picture, x+1, y+1)  
            nextPixelSum = getRed(nextPixel)+ getGreen( ↵  
                        nextPixel) + getBlue(nextPixel)  
            diff = abs(nextPixelSum-pixelSum)  
            newColor = makeColor(diff,diff,diff)  
            setColor(pixel, newColor)
```

Note: This source code excerpt will not work in PyGame.



Source Code: Edge Detection (1)

```
def drawBetterEdges (picture):  
    orig = makePicture (filename)  
    makeBw = makePicture (filename)  
  
    for x in xrange (0,getWidth (picture)-1):  
        for y in xrange (0,getHeight (picture)-1):  
            here=getPixel (makeBw,x,y)  
            down=getPixel (orig,x,y+1)  
            right=getPixel (orig,x+1,y)  
  
            hereL=(getRed (here)+getGreen (here)+getBlue (here) ←  
                ) /3  
            downL=(getRed (down)+getGreen (down)+getBlue (down) ←  
                ) /3  
            rightL=(getRed (right)+getGreen (right)+getBlue ( ←  
                right)) /3  
  
    ...
```

Note: This source code excerpt will not work in PyGame.

Source Code: Edge Detection (2)

```
...  
    if abs (hereL-downL)>10 and abs (hereL-rightL)>10:  
        setColor (here,black)  
    if abs (hereL-downL)<=10 and abs (hereL-rightL) ←  
        <=10:  
        setColor (here,white)  
return makeBw
```

Note: This source code excerpt will not work in PyGame.

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Activity: Edge Detection

In pairs:

- ▶ Setup a basic project in PyGame
- ▶ Refer to the following documentation
- ▶ Refactor the function: `drawBetterEdges (picture)` to use better variable names
- ▶ Test your solution
- ▶ Then, post your solution on Slack
- ▶ 15 minutes

Background Subtraction

- ▶ Let's say that you have a picture of someone, and a picture of the same place (same background) without the someone there, could you subtract out the background and leave the picture of the person?
- ▶ Maybe even change the background?
- ▶ What we most need to do is to figure out whether the pixel in the Person shot is the same as the in the Background shot.
- ▶ Will they be the EXACT same colour? Probably not.

Source Code: Background Subtraction

```
def swapBackground(picture, back, newBack, tolerance):  
    for pixel in getPixels(picture):  
        x = getX(pixel)  
        y = getY(pixel)  
        backPixel = getPixel(back, x, y)  
        pixelColour = getColour(pixel)  
        backColour = getColour(backPixel)  
        if (distance(pixelColour, backColour) < tolerance):  
            newColour = getColour(getPixel(newBack, x, y))  
            setColor(pixel, newColour)
```

Note: This source code excerpt will not work in PyGame.





Problems

- ▶ We've got places where we got pixels swapped that we didn't want to swap
- ▶ We've got places where we want pixels swapped, but didn't get them swapped
 - ▶ Shirt stripes
 - ▶ Shadows
 - ▶ etc.

Activity: Background Subtraction

In pairs:

- ▶ Setup a basic project in PyGame
- ▶ Refer to the following documentation:
 - ▶ <http://www.cs.utah.edu/~michael/chroma/>
- ▶ Implement chroma key as a form of background subtraction
- ▶ Test your solution
- ▶ Then, post your solution on Slack
- ▶ 30 minutes