CS 411 – Computer Graphics

Assignment 1

09/26/2017

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PART 1

1. *Given points*:
   $(x_0, y_0) = (1, 2)$
   $(x_1, y_1) = (3, 4)$
   $dx = 2, \quad dy = 2$
   $2dy - dx = 4 - 2 = 2$
   $\rightarrow 2dy - 2dx = 0$
   $p_0 = 2dy - dx = 2$
   $p_1 = p_0 + 2(dy - dx) = 2 + 2(0) = 2\ (Because\ p_o > 0)$

2. *Given the triangle vertices* (1,1) (2,3) (3,1)
   $Edge = (1,1)\ (2,3)$
   $(x_0, y_0) = (1, 1)$
   $(x_1, y_1) = (2, 3)$
   $Slope\ m = \frac{dy}{dx} = \frac{2}{1} = 2$
   $Intercept\ b = y - 2x$
   $\therefore b = 1 - 2(1) = -1$
   $y = 2$
   $\therefore x = \frac{y - b}{m} = \frac{2 - (-1)}{2} = \frac{3}{2}$
   $Next\ Scanline\ Starting\ Point = (\frac{3}{2}, 2)$

3. *Given triangle vertices* (1,1) (2,2)(3,1)
   Find Normal to Edge: (1,1)(2,2)
   $Vector\ Joining\ Both\ Points = [1,1]$
   $\therefore\ Vector\ Normal\ to\ Edge = [-1,1]$

4. *Given,*
   $A = (2, 3)$
   $B = (3, 2)$
   $A_{proj}\ (Projection\ of\ A\ on\ B) = \frac{A.B}{||A||^2}.A = \left(\frac{36}{13}, \frac{24}{13}\right)$

5. $C = A_{proj} = \left(\frac{36}{13}, \frac{24}{13}\right)$
   $D = A - C = \left(-\frac{10}{13}, \frac{15}{13}\right)$

6. We can determine whether a point is inside a triangle or not if the following equations are satisfied by the barycentric co-ordinates of the point:
    1. $\alpha + \beta + \gamma = 1$
    2. $\alpha,\ \beta,\ \gamma \geq 0$

7. $Given\ triangle\ with\ vertices$:
   $v_0 = (1, 1)$
   $v_1 = (2, 2)$
   $v_2 = (3, 1)$
   $p = \left(\frac{3}{2}, 1\right)$
   $Barycentric\ co-ordinates\ of\ P = (\alpha, \beta, \gamma)$

$$\alpha = \frac{A(p, v_1, v_2)}{A(v_0, v_1, v_2)} = \frac{\frac{1}{2}(-\frac{3}{2})}{\frac{1}{2}(-2)} = \frac{3}{4}$$

$$\beta = \frac{A(p, v_2, v_0)}{A(v_0, v_1, v_2)} = \frac{\frac{1}{2}(0)}{\frac{1}{2}(-2)} = 0$$

$$\gamma = \frac{A(p, v_0, v_1)}{A(v_0, v_1, v_2)} = \frac{\frac{1}{2}(-\frac{1}{2})}{\frac{1}{2}(-2)} = \frac{1}{4}$$

8. The maximum of sub-pixels covered by the line in each of the pixels it crosses is 2. Given that (2, 1) has 2 sub-pixels which is part of the line, it has max intensity.

9. Each of pixels of the convolution filter has a value of 1/9. Each of the surrounding pixels has a value of two, so the weight of each pixel in convolution filter is 2/9. Given there are 9 pixels, the resultant value is 9(2/9) = 2.

PART 2

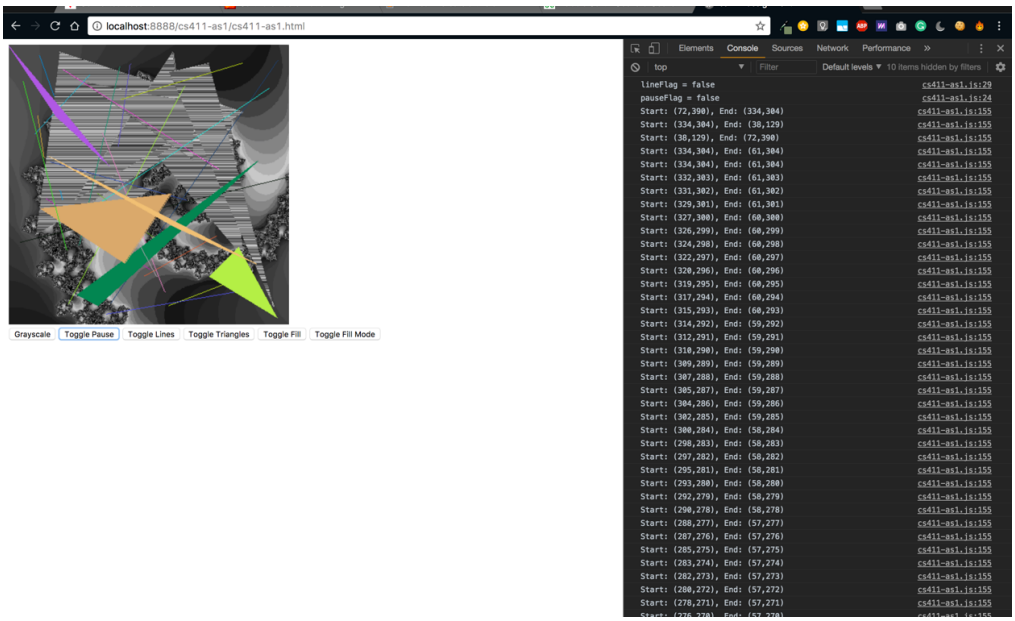
The first problem that I encountered was a Cross-Origin Request Error. I tried running the support code on Firefox, but it didn't work. I added the line: img.CrossOrigin = "Anonymous" but that didn't work either. I put all the files on my Apache server and then ran the code from my localhost and it worked.

I first attempted to replace the drawLine function, and while I was writing Bressenham's algorithm, I started getting lines, but all of them had a slope of less than 1 (Quadrant 1). I started checking for slope > 1 and changed the algorithm accordingly and it got better, but it wasn't printing negative slopes. That code was checking for slope and accordingly either printing using x or using the y co-ordinate. I then wrote a function to check for negative slope, and I would use the sign to determine whether I should increment or decrement x or y. Then the Bressenham's algorithm worked.

After that, I attempted to change the DrawTriangle function. Initially, sorting the 3 vertices based on the max y co-ord was a problem because I had referenced the sort array wrong. After getting the vertices and calculating v4, I could plot a triangle with the baseline for fillTop & fillBottom.

When I wrote the fillTop & fillBottom, I had to write too many console.log()s as it wouldn't fill. Turns out I was passing the vertices in the wrong order, and it was trying to fill the triangle as y(start) and y(end) to be the same. Apart from that m0, b0, m2, b2 were being calculated wrong as m0 was Infinity because the vertices were being passed wrong. So of-course the lines weren't being drawn. After I changed the order of the vertices, the y variable was accordingly not the same, so the for-loop for drawing the lines was working. I added the fillModeToggle along with the button and the whole program worked.

Sample Input / Output



Tested on Chrome Version 61.0.3163.79 (Official Build) (64-bit)