2973140 - Felix Bühler
2893121 - Jan Leusmann
3141241 - Jamie Ullerich

Exercise 8

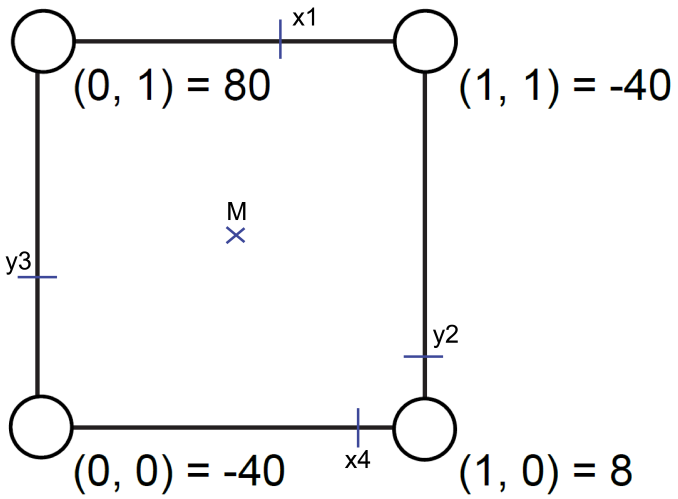
Exercise 8.1 - Asymptotic Decider

We assume that the Isoline should be drawn at f(x) = 0

Interpolate values:

$$x_1 = \frac{(-40-0)\cdot 0 + (0-80)\cdot 1}{-40-80} = \frac{-80}{-120} = 0.66$$
$$y_2 = \frac{(8-0)\cdot 1 + (0+40)\cdot 0}{8+40} = \frac{8}{48} = 0.17$$
$$y_3 = \frac{(-40-0)\cdot 1 + (0-80)\cdot 0}{-40-80} = \frac{-40}{-120} = 0.33$$
$$x_4 = \frac{(8-0)\cdot 0 + (0+40)\cdot 1}{8+40} = \frac{40}{48} = 0.834$$

Result:



Midpoint (M):

$$\begin{aligned} c &= \frac{1}{4} * (f_{i,j} + f_{i+1,j} + f_{i,j+1} + f_{i+1,j+1}) \\ &= \frac{1}{4} * (-40 + 8 + 80 - 40) \\ &= 2 \end{aligned}$$

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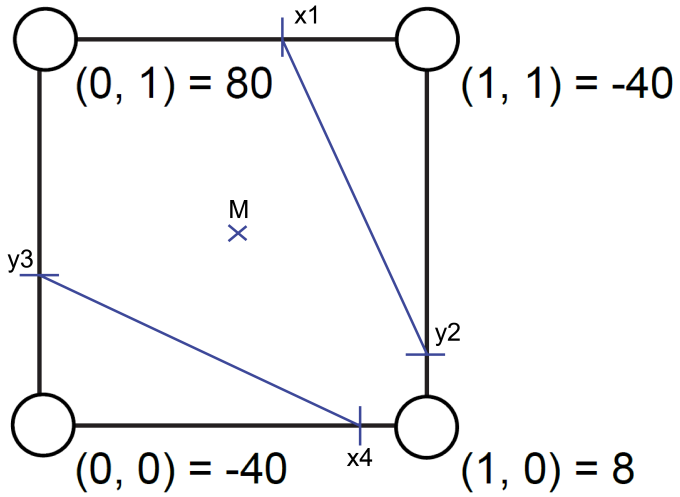
Because $c > 0$, our lines are drawn the following:



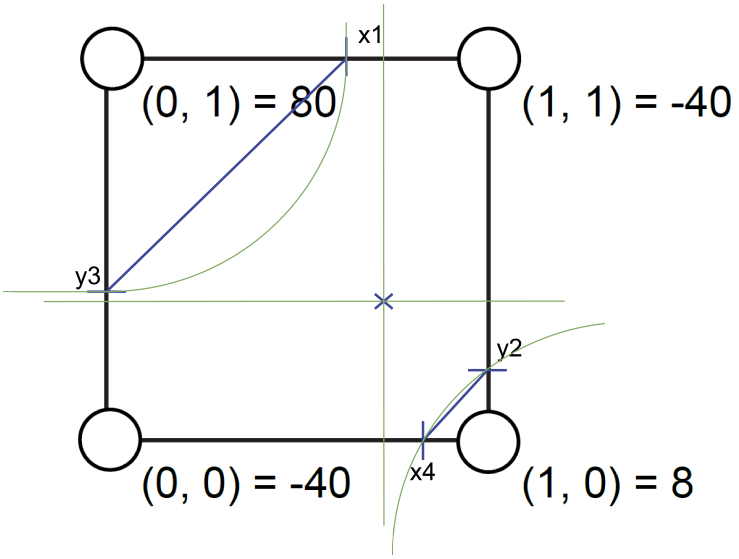
We now just need to calculate the f value at the intersection of our asymptotes (S_α, T_α): (see Nielson: The asymptotic decider: resolving the ambiguity in marching cubes.)

$$f(S_\alpha, T_\alpha) = \frac{f_{00} \cdot f_{11} + f_{10} \cdot f_{01}}{f_{00} + f_{11} - f_{01} - f_{10}} = \frac{-40 \cdot -40 + 8 \cdot 80}{-40 + -40 - 80 - 8} = \frac{2240}{-168} = -13.34$$

$$S_\alpha = \frac{f_{00} - f_{01}}{f_{00} + f_{11} - f_{01} - f_{10}} = \frac{-40 - 80}{-40 + (-40) - 80 - 8} = \frac{-120}{-168} = 0.714$$

$$T_\alpha = \frac{f_{00} - f_{10}}{f_{00} + f_{11} - f_{01} - f_{10}} = \frac{-40 - 8}{-40 + (-40) - 80 - 8} = \frac{-48}{-168} = 0.286$$

Result:



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Exercise 8.2 - Octrees

32bit floating point $\rightarrow$ 4bytes for each voxel
only the last layer needs to store these voxels which contains $500 * 500 * 200 = 50.000.000$ nodes

$$
\begin{aligned}
8^x \leq 50.000.000 \Rightarrow x = 9 \\
layer_9 = 8^9 = 134.217.728 \text{ leaves} \\
layer_8 = 8^8 = 16.777.216 \text{ leaves} \\
layer_7 = 8^7 = 2.097.152 \text{ leaves} \\
layer_6 = 8^6 = 262.144 \text{ leaves} \\
layer_5 = 8^5 = 32.768 \text{ leaves} \\
layer_4 = 8^4 = 4096 \text{ leaves} \\
layer_3 = 8^3 = 512 \text{ leaves} \\
layer_2 = 8^2 = 64 \text{ leaves} \\
layer_1 = 8^1 = 8 \text{ leaves} \\
layer_0 = 8^0 = 1 \text{ leaves}
\end{aligned}
$$

(a)

$$
\begin{aligned}
&= 134.217.728 * 4 \text{ bytes} \\
&= 536870912 \\
&\approx 537 \text{ MB}
\end{aligned}
$$

(b)

$$
\begin{aligned}
&= 134.217.728 + 2 * (16.777.216 + 2.097.152 + 262.144 + 32.768 + 4096 + 512 + 64 + 8 + 1) \\
&= 172.565.650 * 4 \text{ bytes} \\
&= 690262600 \text{ bytes} \\
&\approx 690\text{MB}
\end{aligned}
$$

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Exercise 8.3 - Color Mapping with Shaders

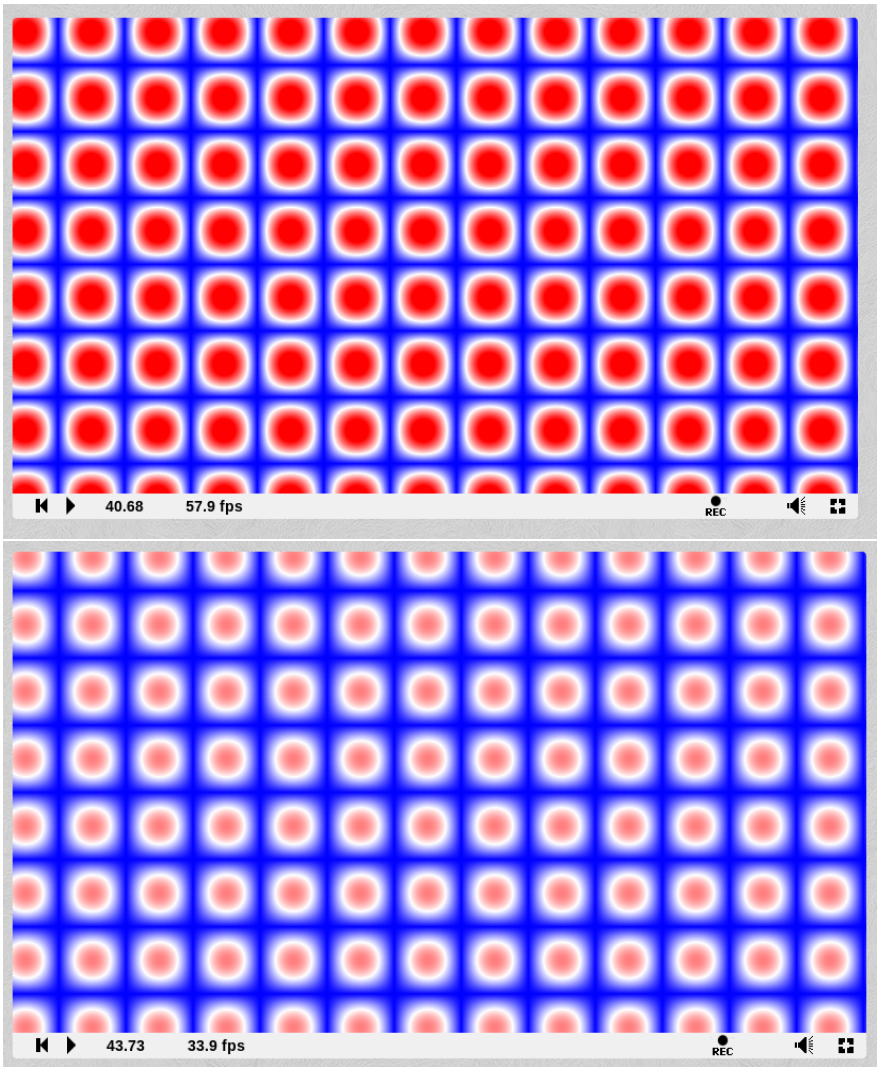

Figure 1: Screenshots