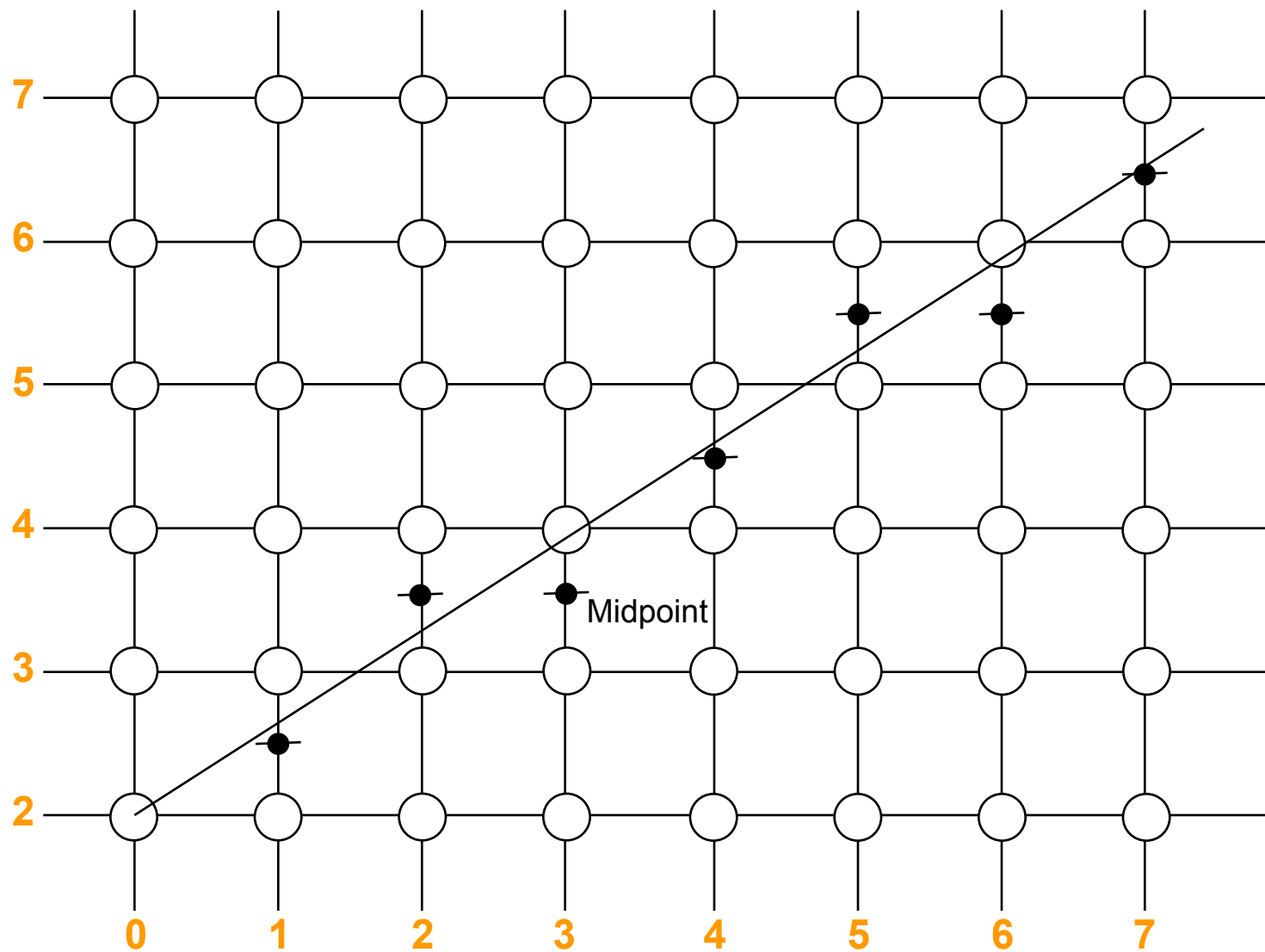
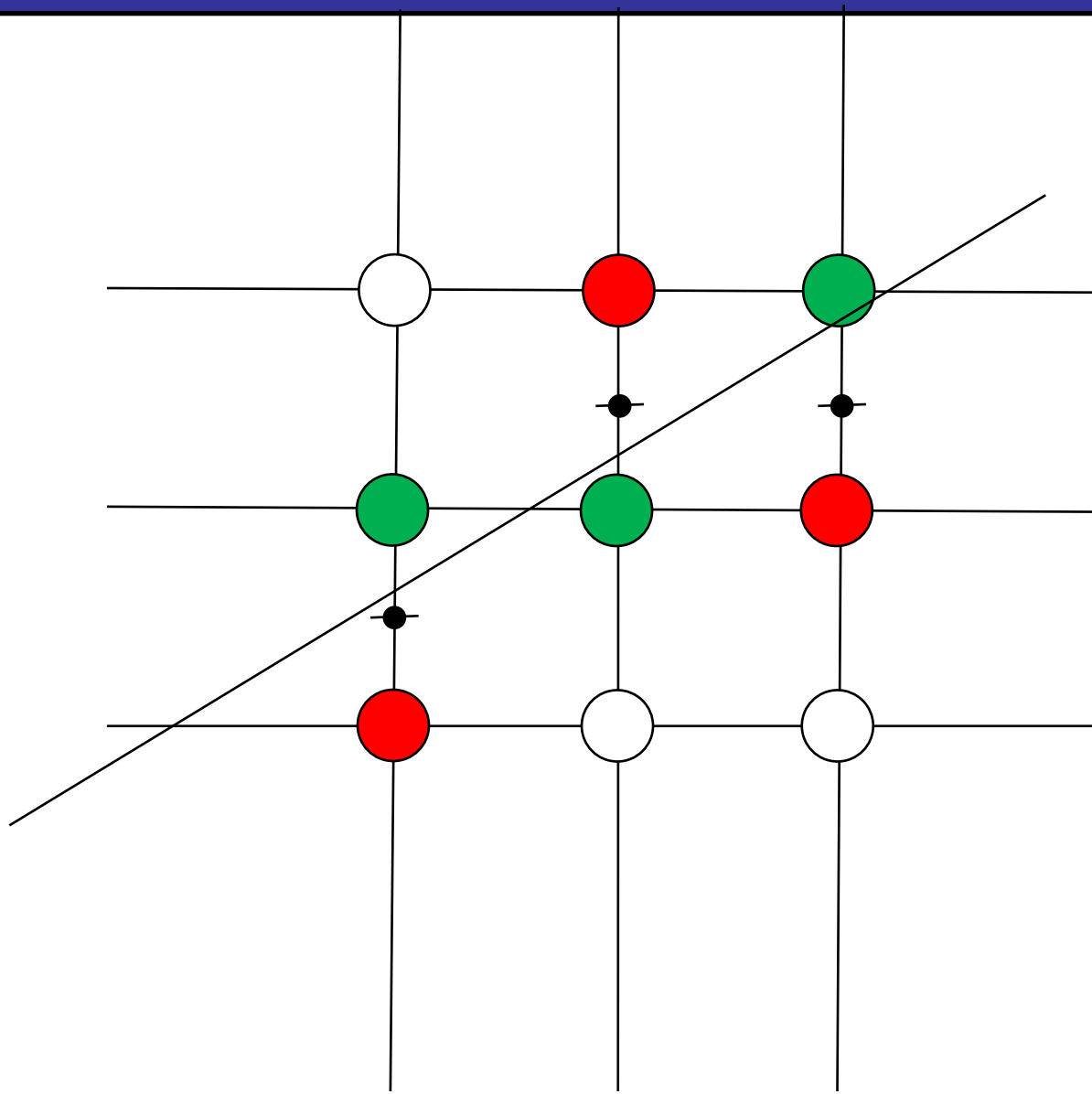
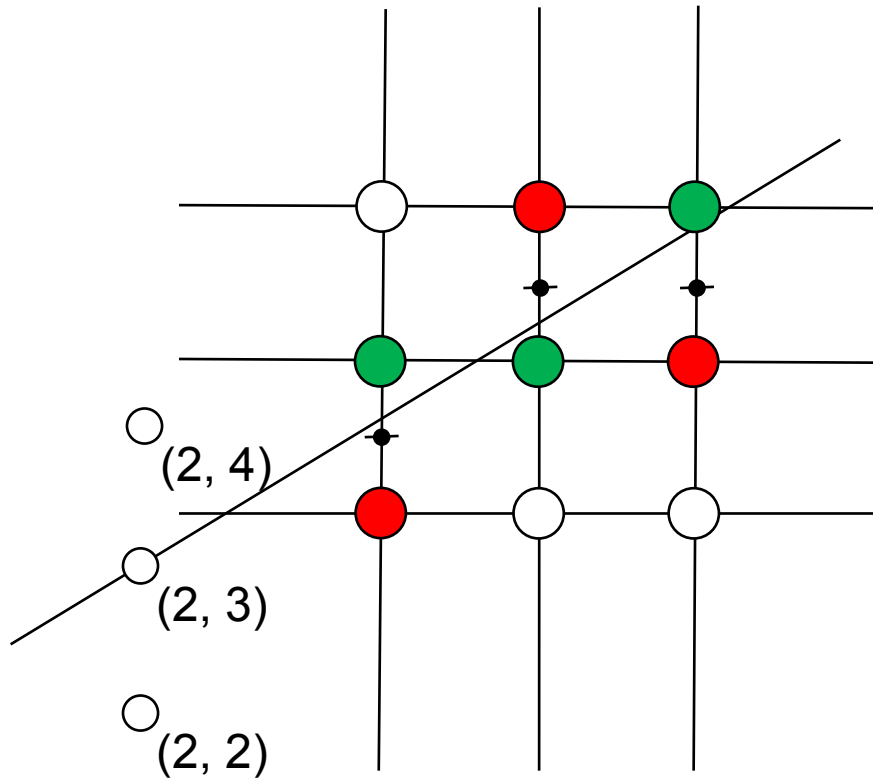


Computer Graphics: Line Drawing Algorithms

Scan Conversion Algorithms
(Midpoint Line)





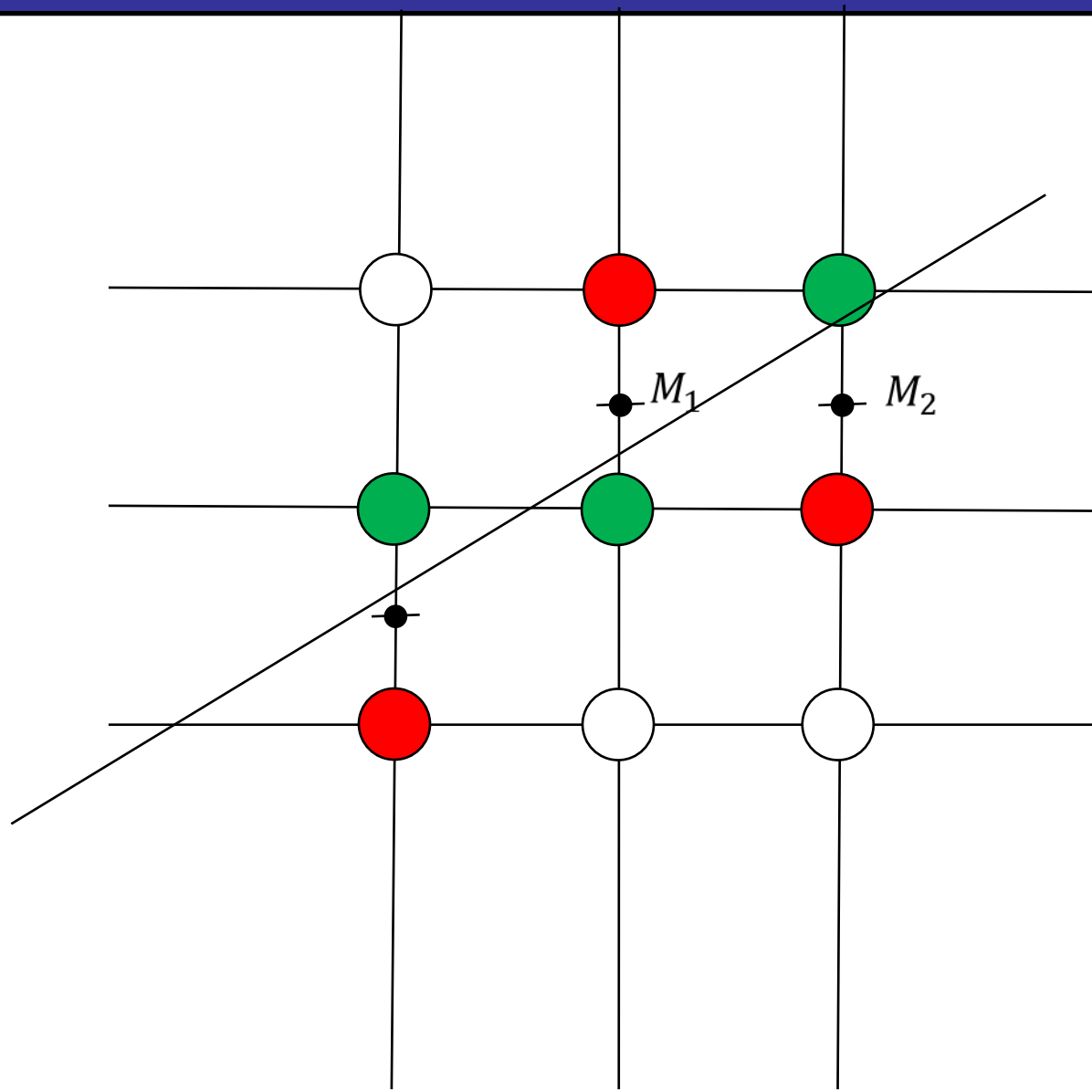


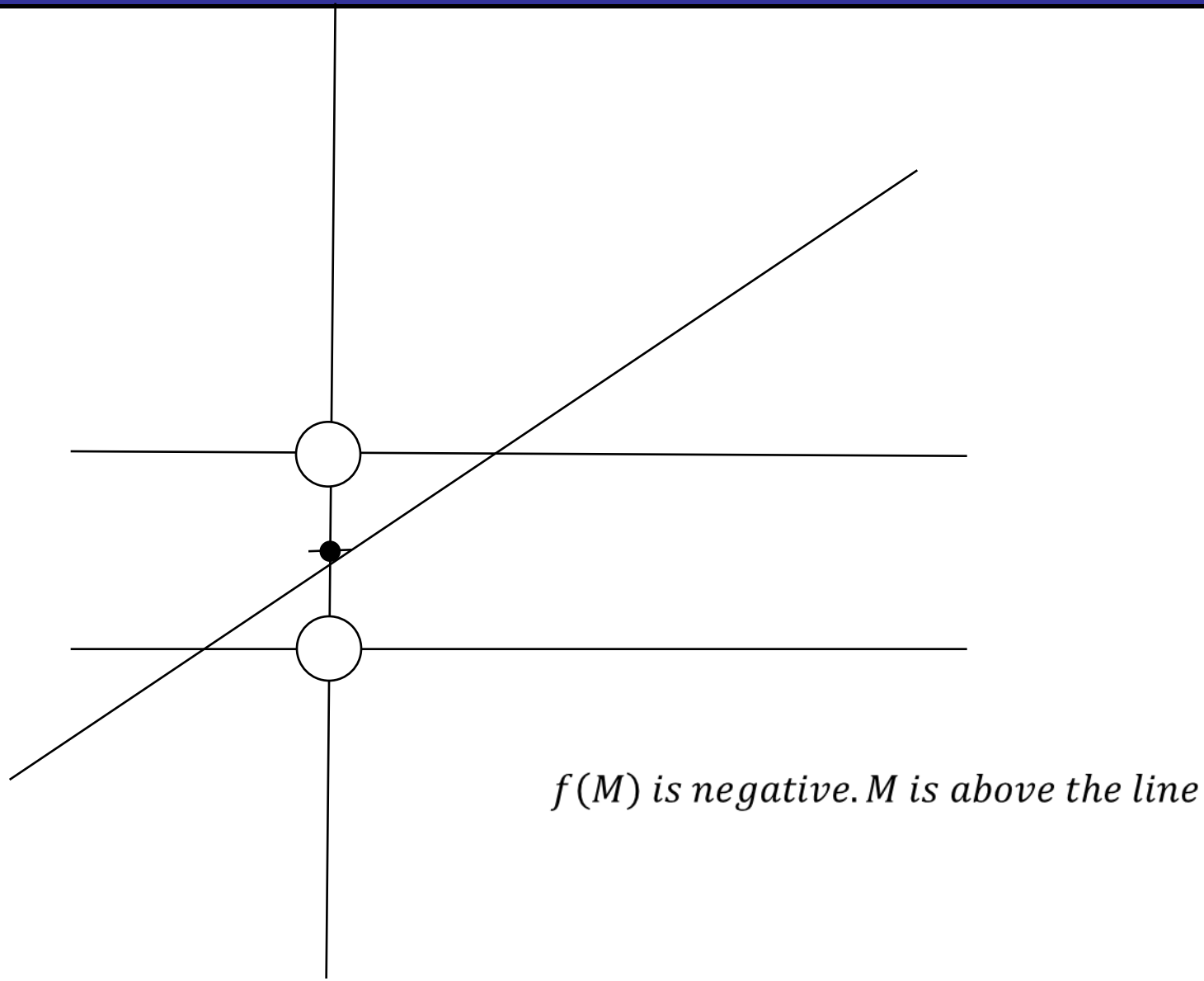
$$ax + by + c = 0$$

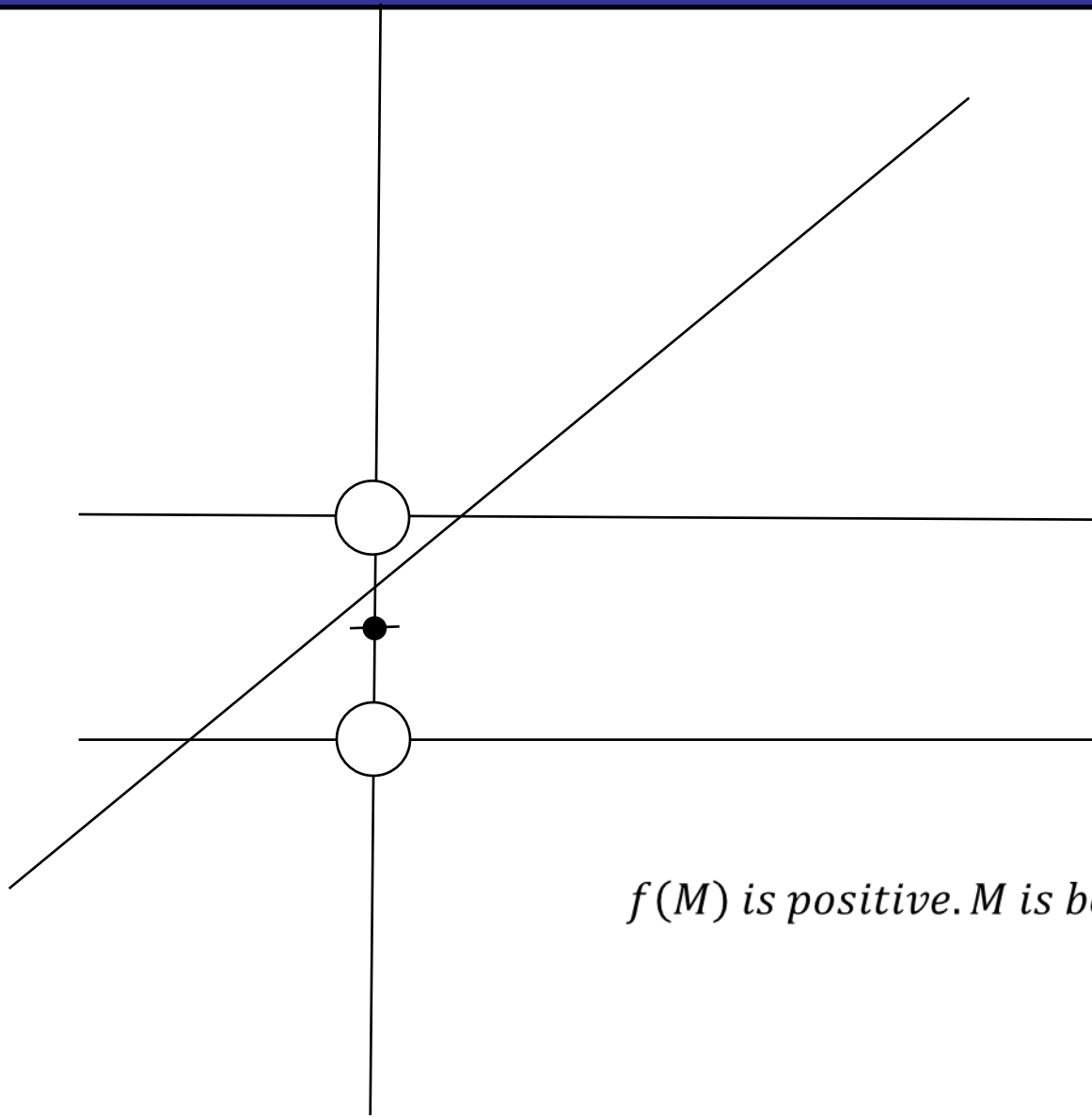
$$f(x, y) = ax + by + c$$

$$f(2, 4) = (-)ve$$

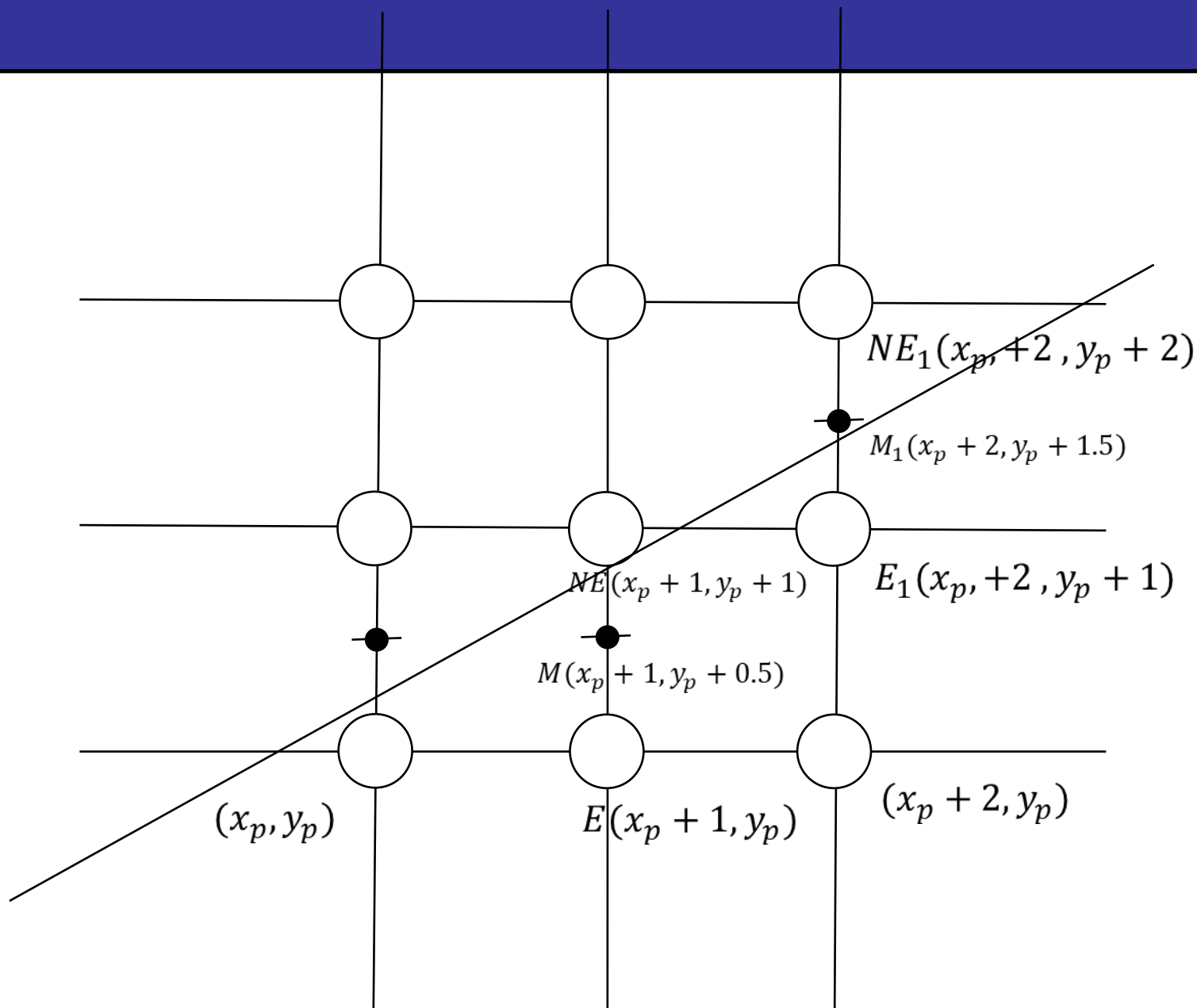
$$f(2, 2) = (+)ve$$

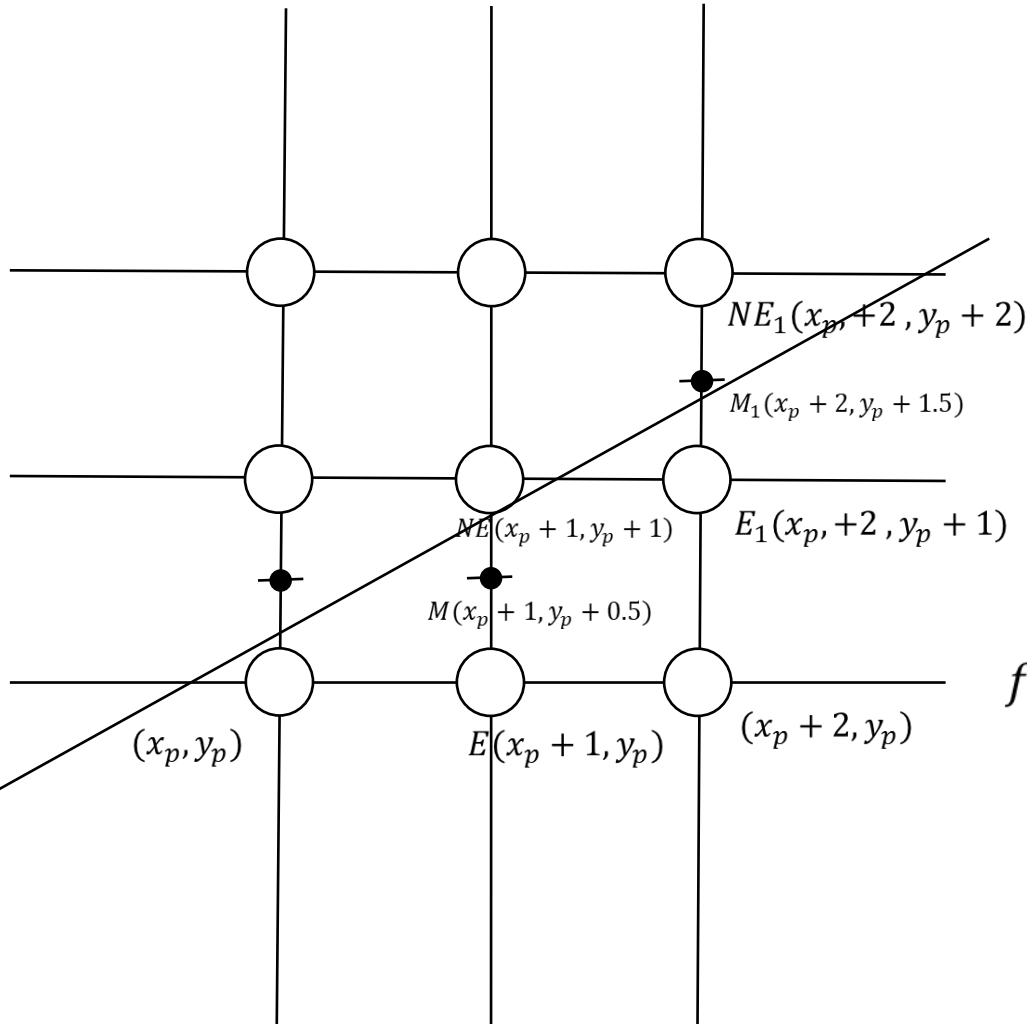






| $f(M)$ | Pixel chosen |
|---------------|--------------|
| $f(M) > 0$ | upper (NE) |
| $f(M) \leq 0$ | lower (E) |



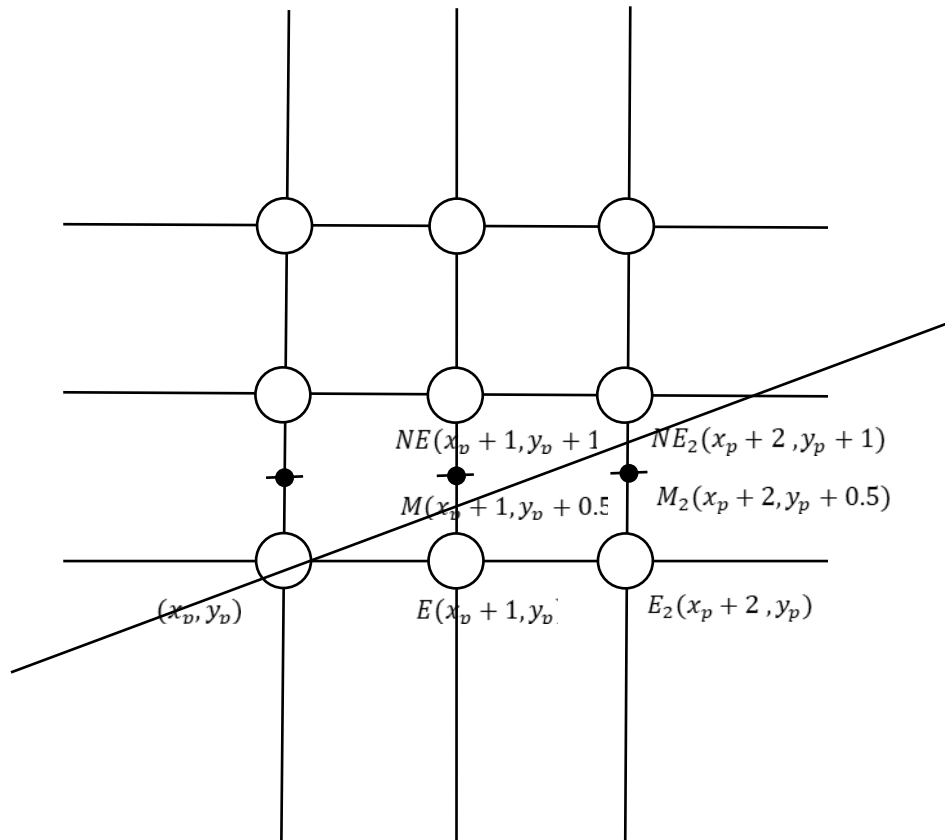


$$\begin{aligned}
 f(M) &= f(x_p + 1, y_p + 0.5) \\
 &= a(x_p + 1) + b(y_p + 0.5) + c \\
 d &= ax_p + by_p + c + a + 0.5b
 \end{aligned}$$

$d > 0$, so NE is chosen

$$\begin{aligned}
 f(M_1) &= f(x_p + 2, y_p + 1.5) \\
 &= a(x_p + 2) + b(y_p + 1.5) + c \\
 d_{new} &= ax_p + by_p + c + 2a + 1.5b
 \end{aligned}$$

$$\begin{aligned}
 d_{new} - d &= a + b \\
 d_{new} &= d + a + b
 \end{aligned}$$



$$\begin{aligned}
 f(M) &= f(x_p + 1, y_p + 0.5) \\
 &= a(x_p + 1) + b(y_p + 0.5) + c \\
 d &= ax_p + by_p + c + a + 0.5b \\
 d &\leq 0, \text{ so } E \text{ is chosen}
 \end{aligned}$$

$$\begin{aligned}
 f(M_2) &= f(x_p + 2, y_p + 0.5) \\
 &= a(x_p + 2) + b(y_p + 0.5) + c \\
 d_{\text{new}} &= ax_p + by_p + c + 2a + 0.5b
 \end{aligned}$$

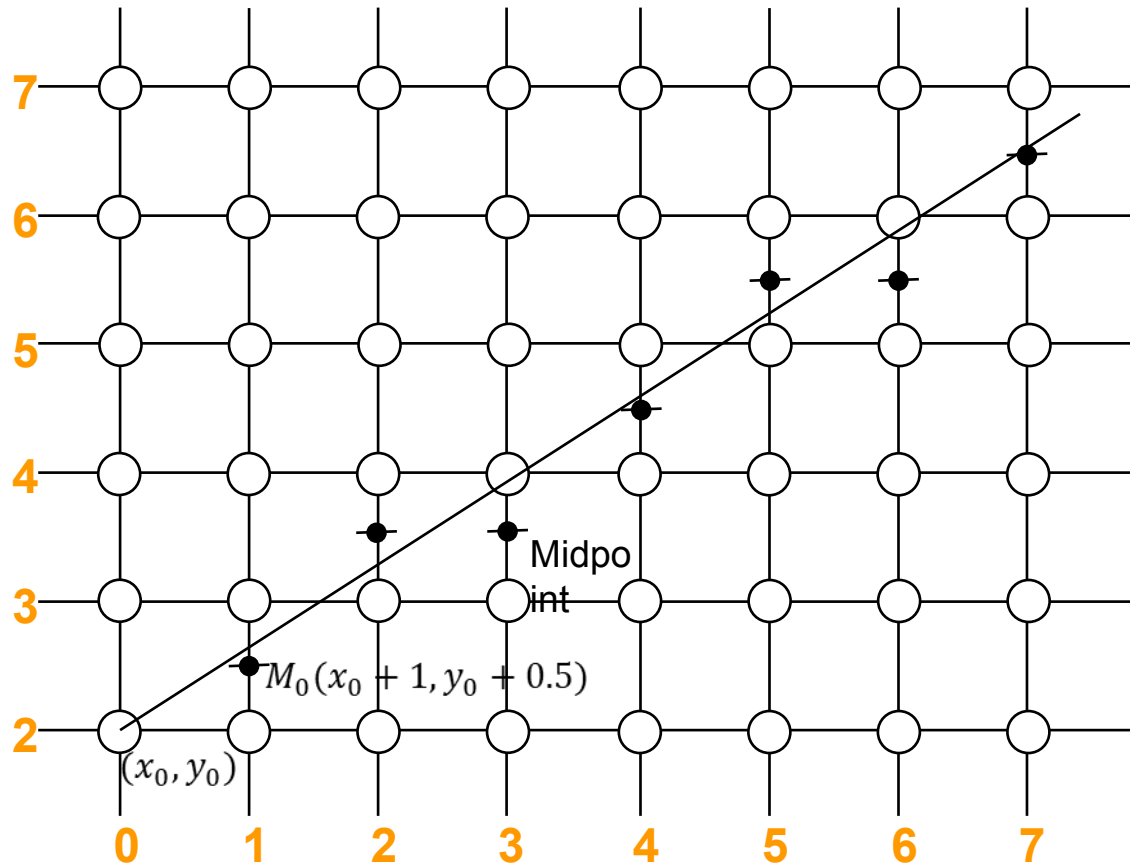
$$\begin{aligned}
 d_{\text{new}} - d &= a \\
 d_{\text{new}} &= d + a
 \end{aligned}$$

Calculate d for 1st column.

Choose E/NE.

Update d_{new} acc. to E/NE.

Use d_{new} to choose E/NE again and repeat the loop until the end.

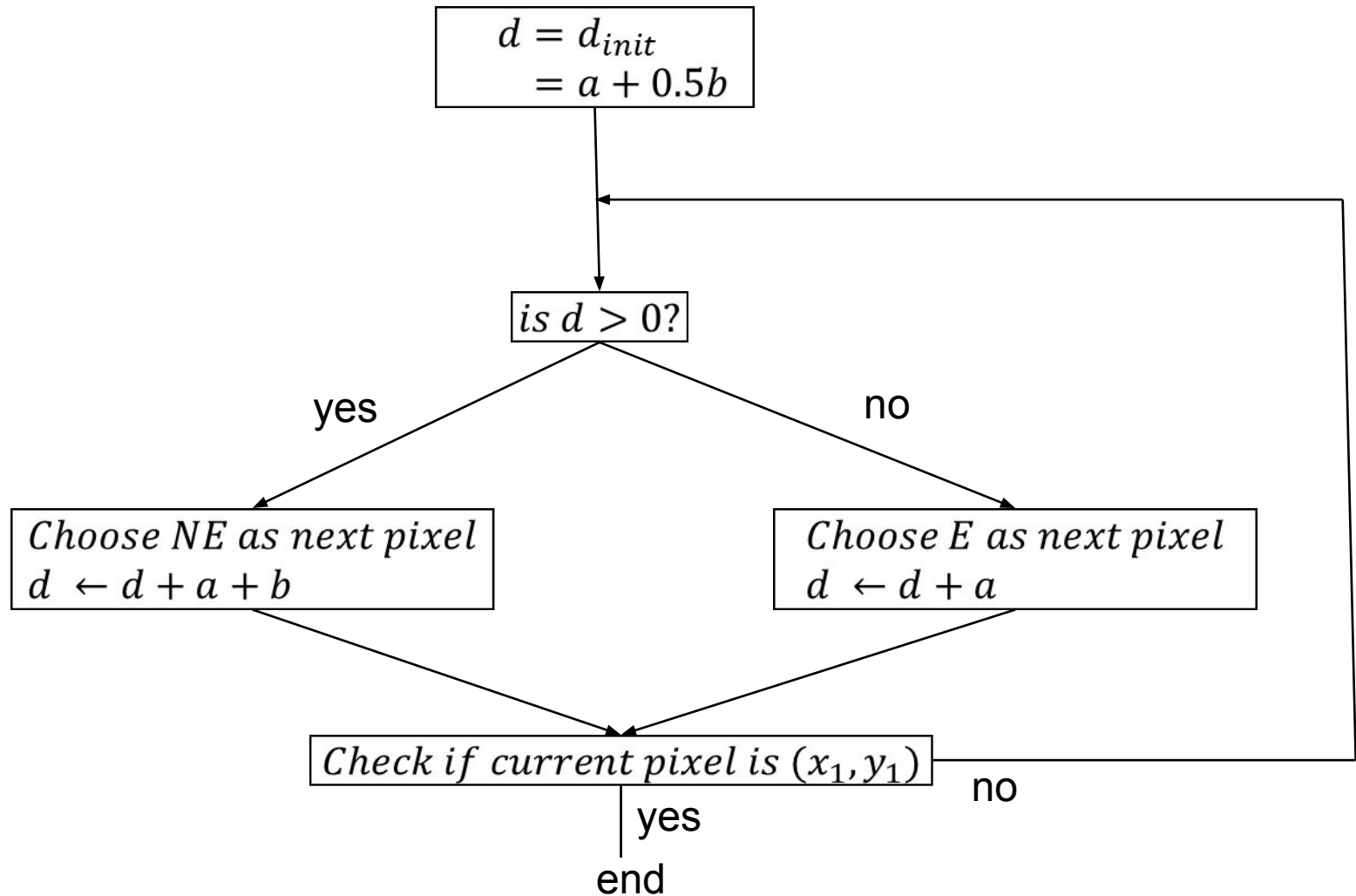


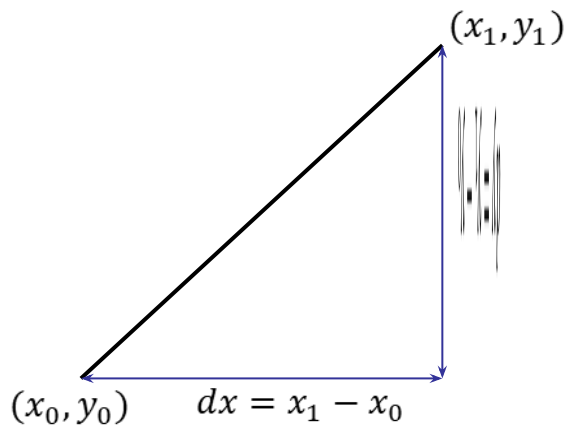
$$\begin{aligned}
 d_{init} &= f(M_0) \\
 &= f(x_0 + 1, y_0 + 0.5) \\
 &= a(x_0 + 1) + b(y_0 + 0.5) + c \\
 &= ax_0 + a + by_0 + 0.5b + c \\
 d_{init} &= ax_0 + by_0 + c + a + 0.5b
 \end{aligned}$$

$$\begin{aligned}
 ax + by + c &= 0 \\
 \text{true for all } (x, y) \text{ on the line}
 \end{aligned}$$

$$\text{So, } ax_0 + by_0 + c = 0$$

$$\begin{aligned}
 d_{init} &= ax_0 + by_0 + c + a + 0.5b \\
 &= 0 + a + 0.5b \\
 &= a + 0.5b
 \end{aligned}$$





$$y = mx + B$$

$$m = \frac{dy}{dx} \text{ where } dy = y_1 - y_0 \text{ and } dx = x_1 - x_0$$

$$y = \frac{dy}{dx} \cdot x + B$$

$$y \cdot dx = dy \cdot x + B \cdot dx$$

$$0 = dy \cdot x - y \cdot dx + B \cdot dx$$

$$dy \cdot x - dx \cdot y + B \cdot dx = 0$$

Comparing this with,

$$ax + by + c = 0$$

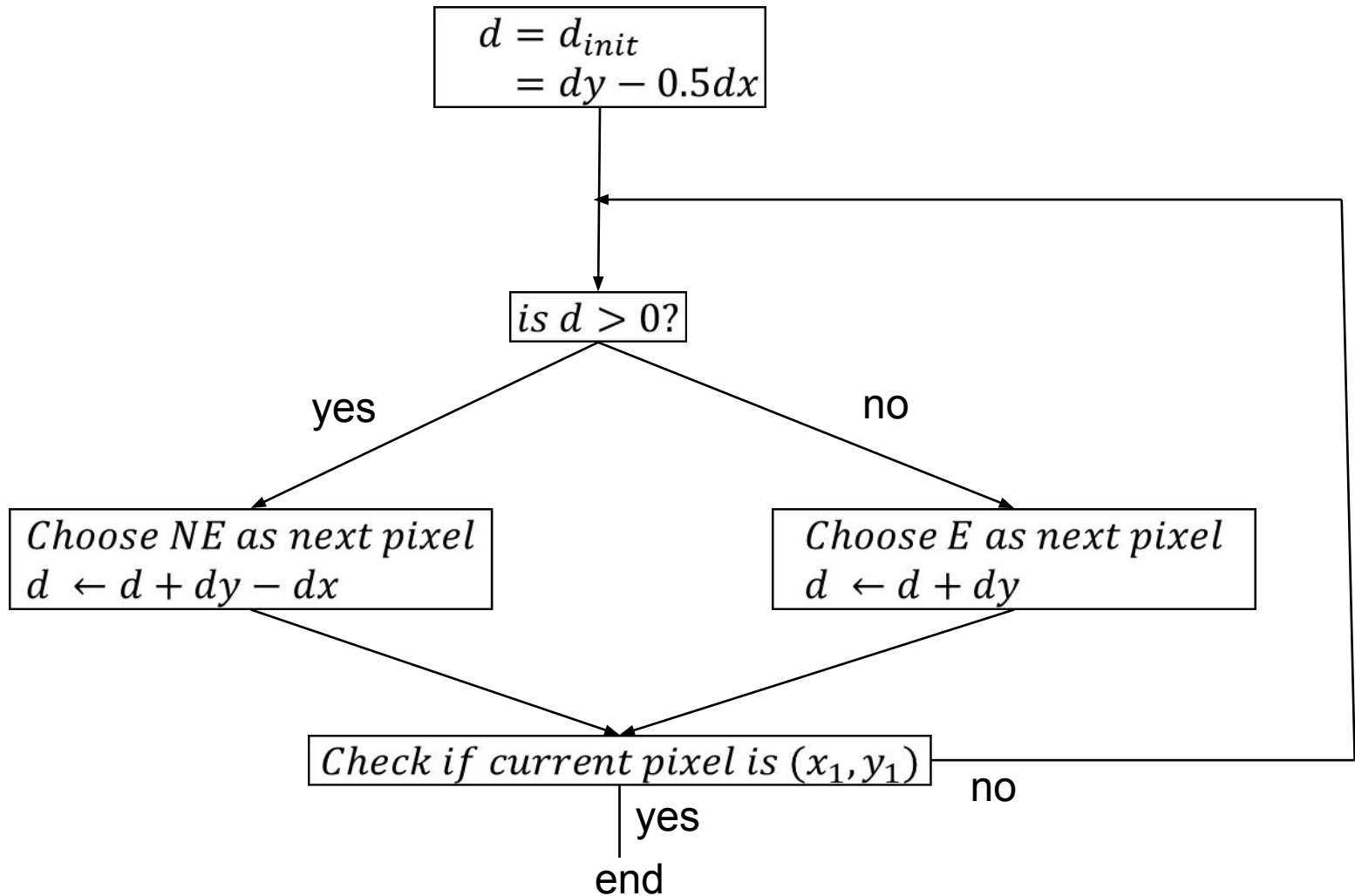
We get,

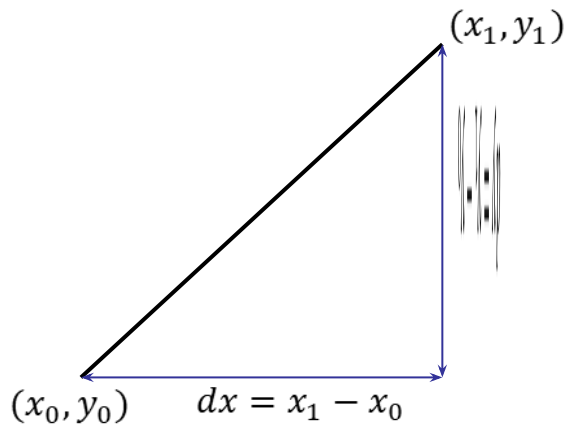
$$a = dy$$

$$b = -dx$$

$$c = B \cdot dx$$

Putting,
 $a = dy$
 $b = -dx$





$$y = mx + b$$

$$m = \frac{dy}{dx} \text{ where } dy = y_1 - y_0 \text{ and } dx = x_1 - x_0$$

$$y = \frac{dy}{dx} \cdot x + b$$

$$y \cdot dx = dy \cdot x + b \cdot dx$$

$$0 = dy \cdot x - y \cdot dx + b \cdot dx$$

$$\mathbf{dy \cdot x - dx \cdot y + b \cdot dx = 0}$$

Comparing this with,

$$\mathbf{ax + by + c = 0}$$

We get,

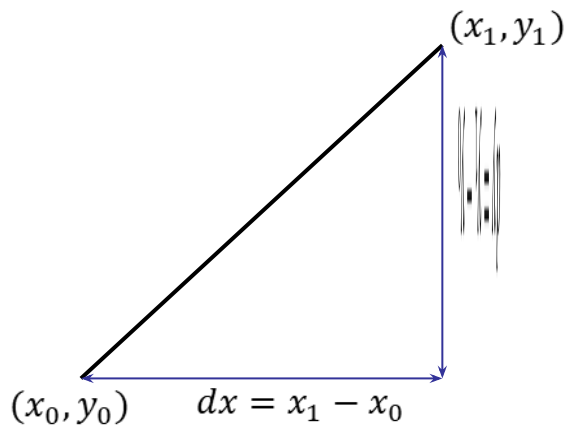
$$a = dy$$

$$b = -dx$$

$$c = b \cdot dx$$

$$2x + 3y + 1 = 0$$

$$4x + 6y + 2 = 0$$



$$y = mx + b$$

$$m = \frac{dy}{dx} \text{ where } dy = y_1 - y_0 \text{ and } dx = x_1 - x_0$$

$$y = \frac{dy}{dx} \cdot x + b$$

$$y \cdot dx = dy \cdot x + b \cdot dx$$

$$0 = dy \cdot x - y \cdot dx + b \cdot dx$$

$$2dy \cdot x - 2dx \cdot y + 2b \cdot dx = 0$$

Comparing this with,

$$ax^2 + by^2 + c = 0$$

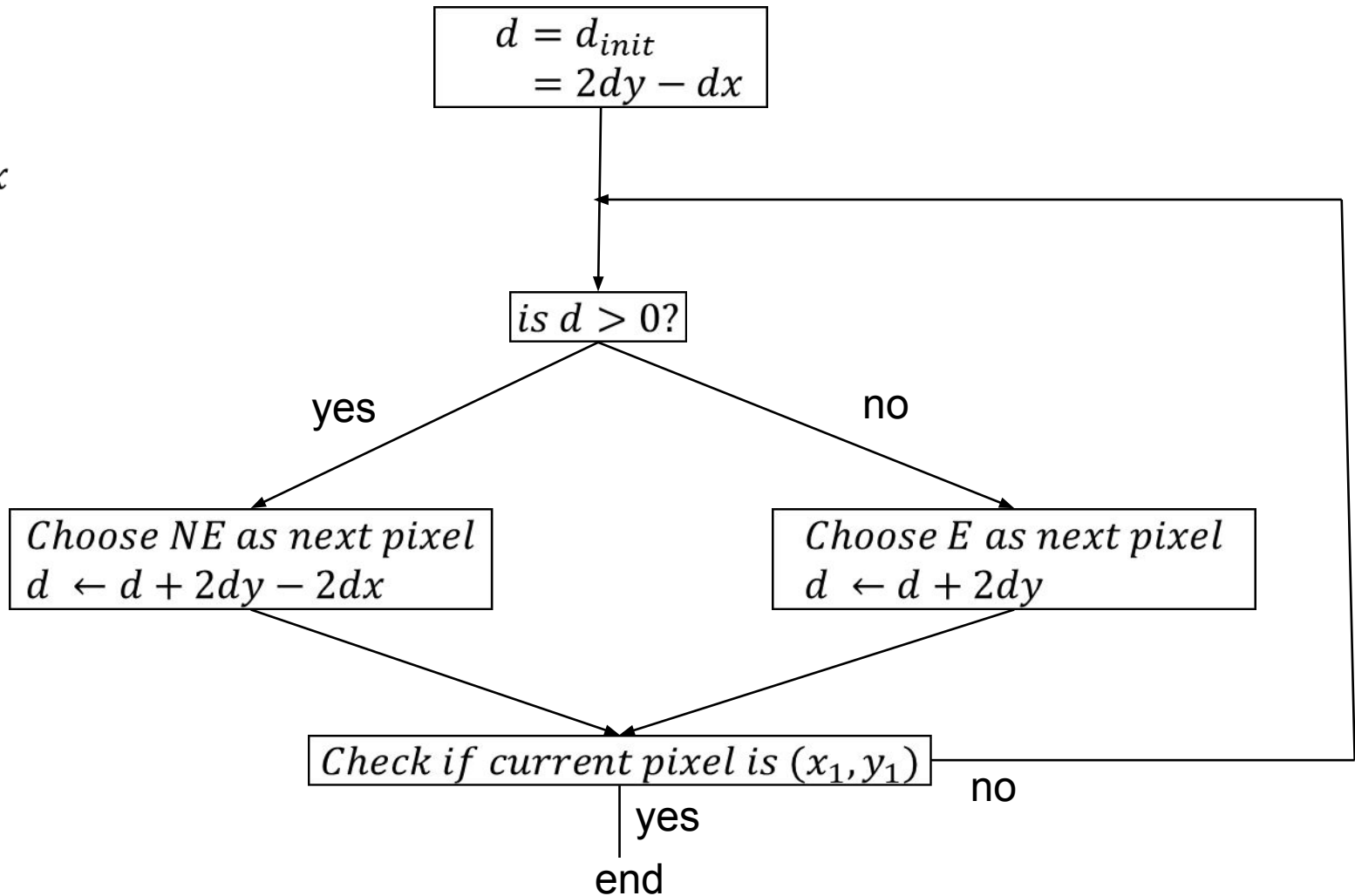
We get,

$$a = 2dy$$

$$b = -2dx$$

$$c = 2b \cdot dx$$

Putting,
 $a = 2dy$
 $b = -2dx$



```
func MidpointLine(int x0, int y0, int x1, int y1, int value){
    int dx, dy, incrE, incrNE, d, x, y;
    dx = x1 - x0;
    dy = y1 - y0;
    d = 2 * dy - dx;
    incrE = 2 * dy;
    incrNE = 2 * (dy - dx);
    x = x0;
    y = y0;
    WritePixel (x, y, value);
    while (x < x1) {
        if (d <= 0) {
            //choose E
            d = d + incrE;
            x = x + 1;
        }
        else {
            //choose NE
            d = d + incrNE;
            x = x + 1;
            y = y + 1;
        }
        WritePixel (x,y, value) //The selected pixel closest to the line
    }
}
```