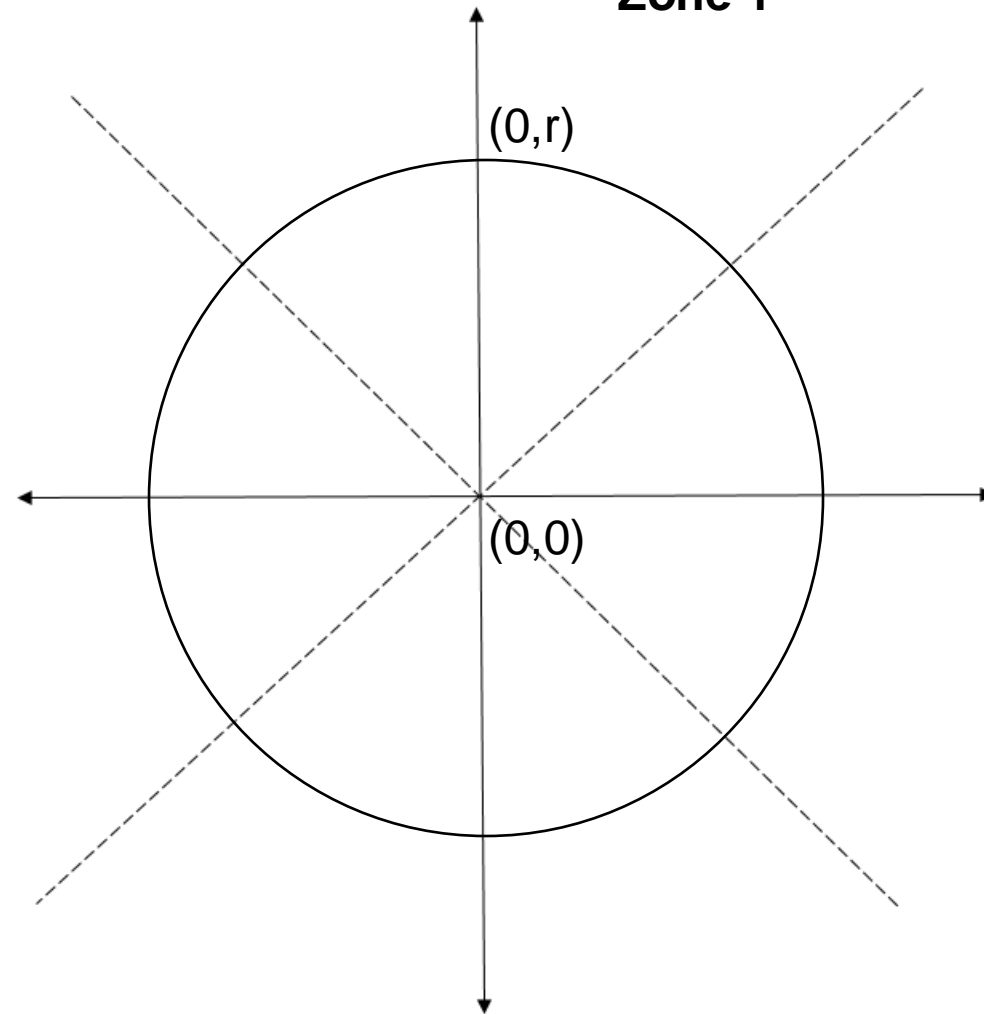
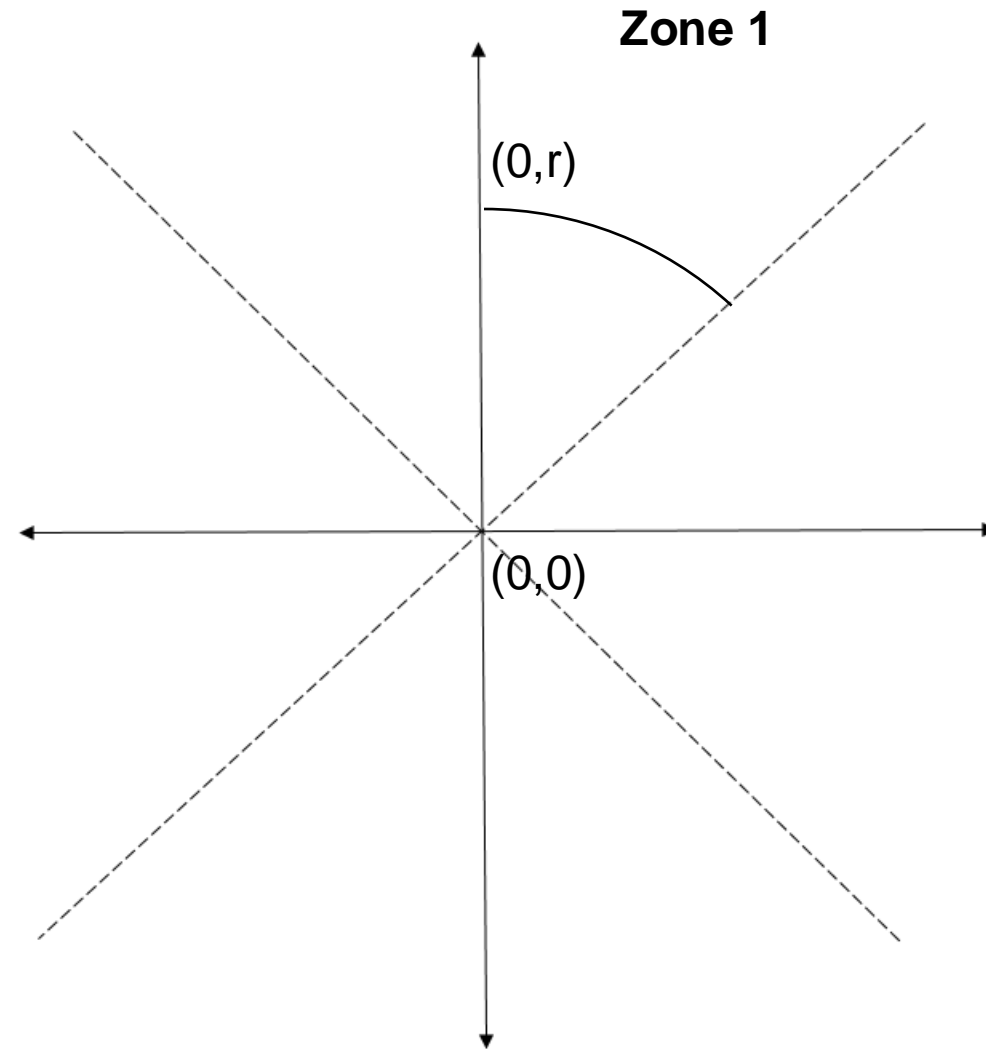


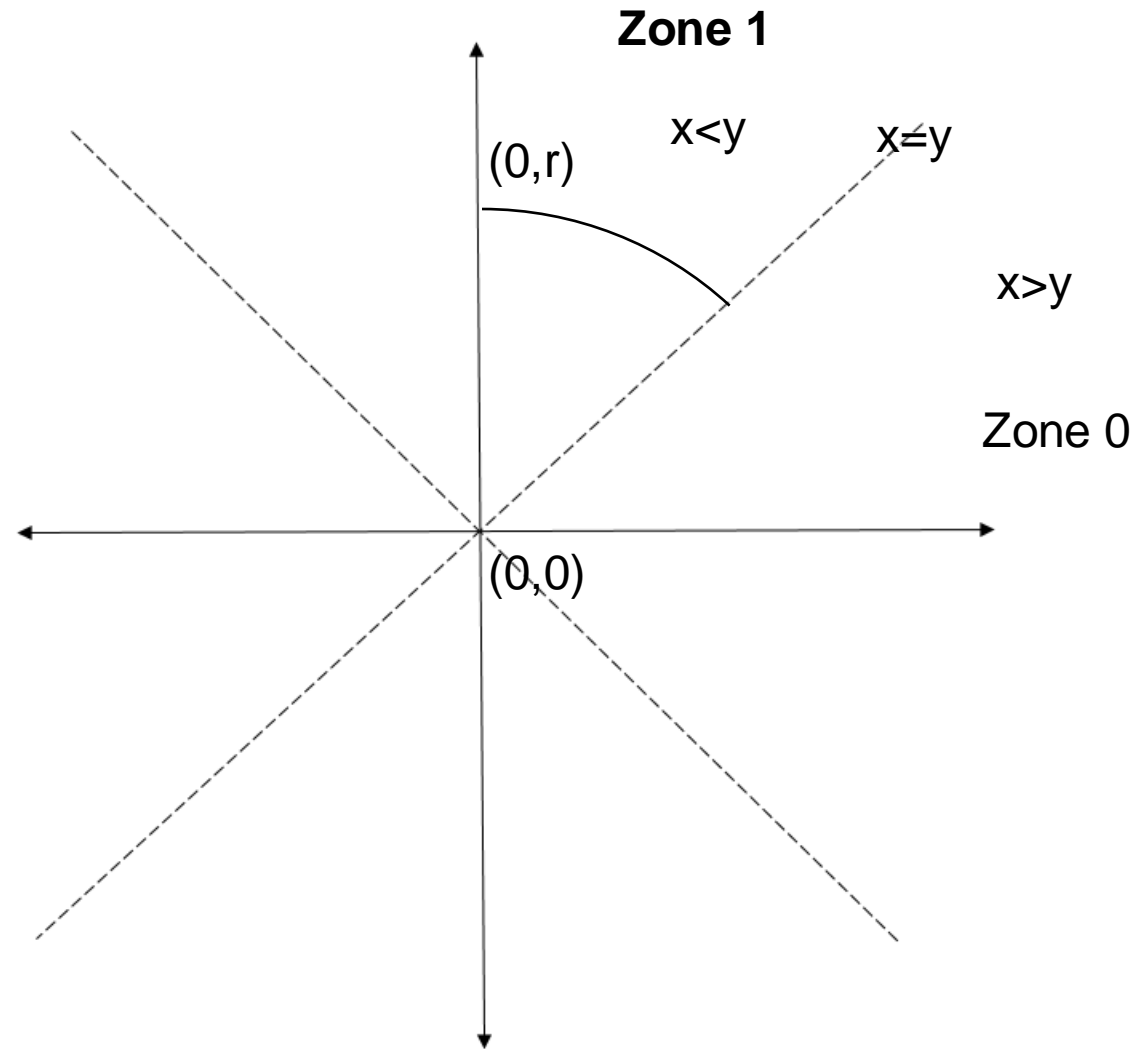
Computer Graphics: Line Drawing Algorithms

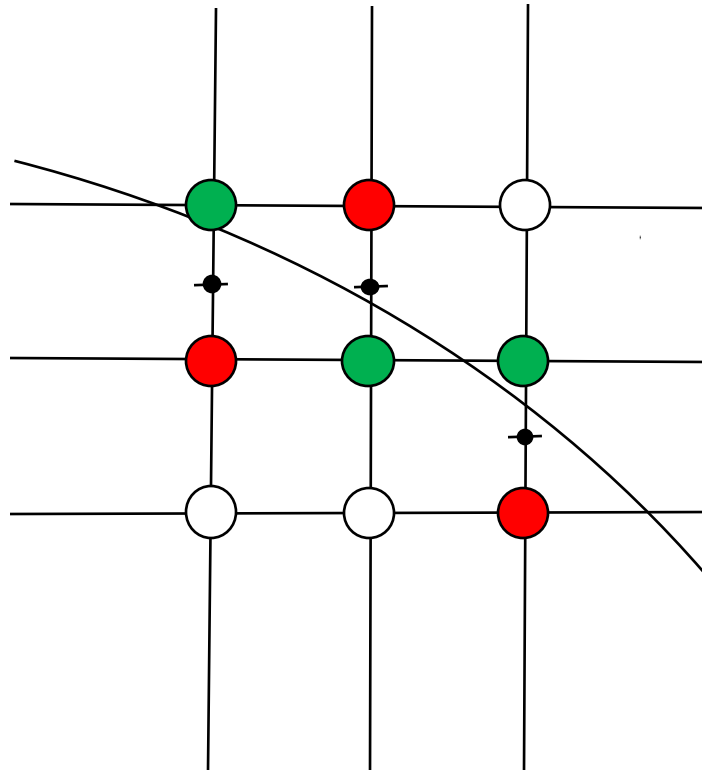
Scan Conversion Algorithms
(Midpoint Circle)

Zone 1

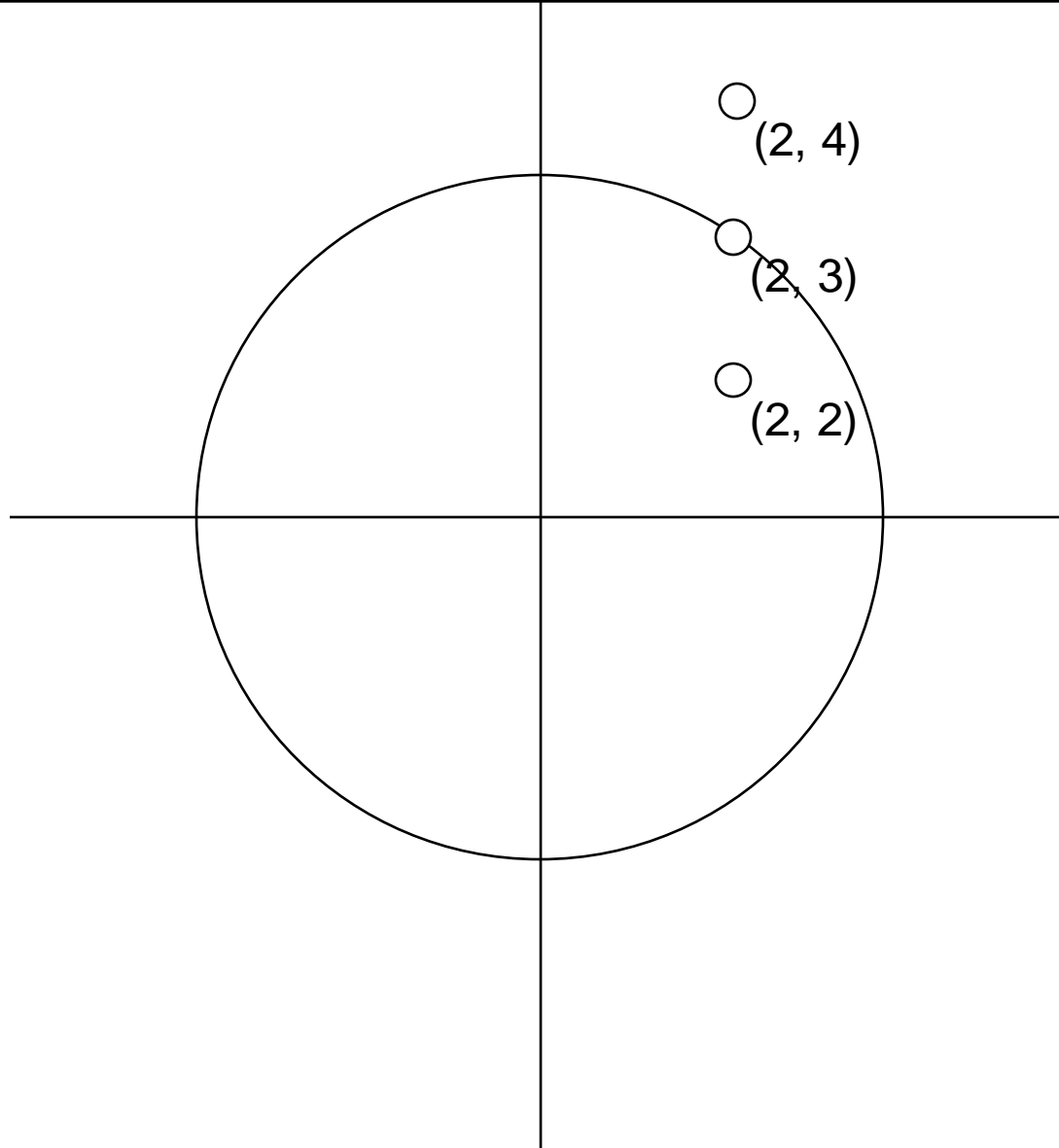




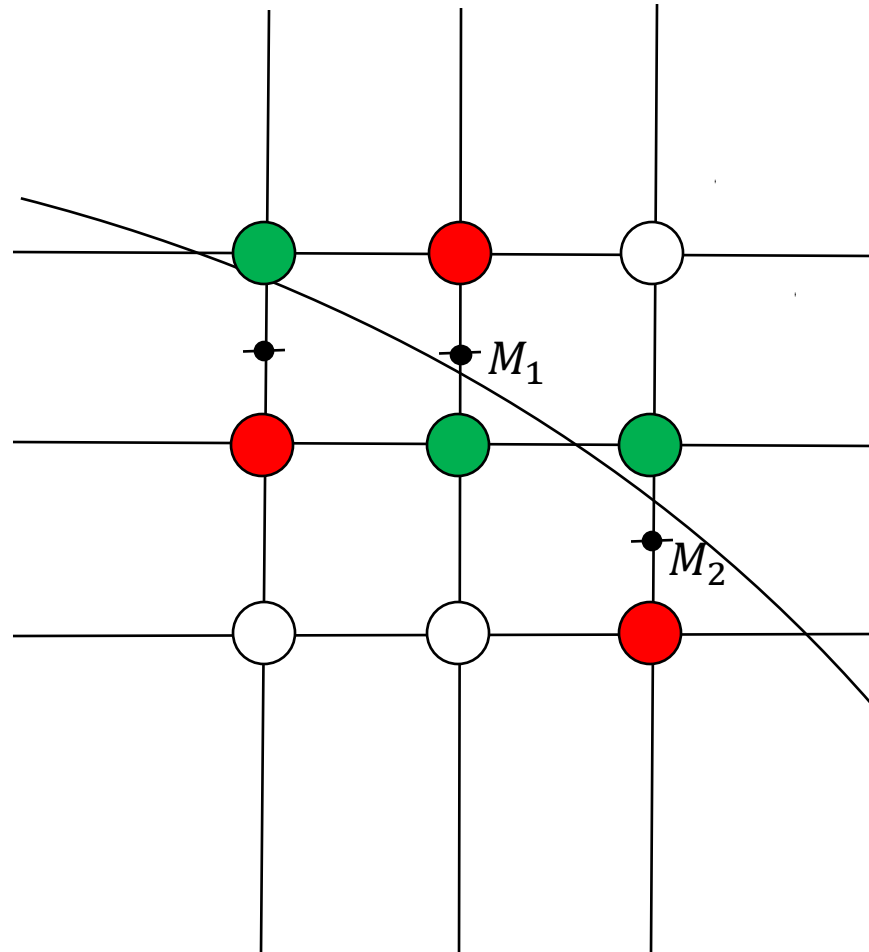


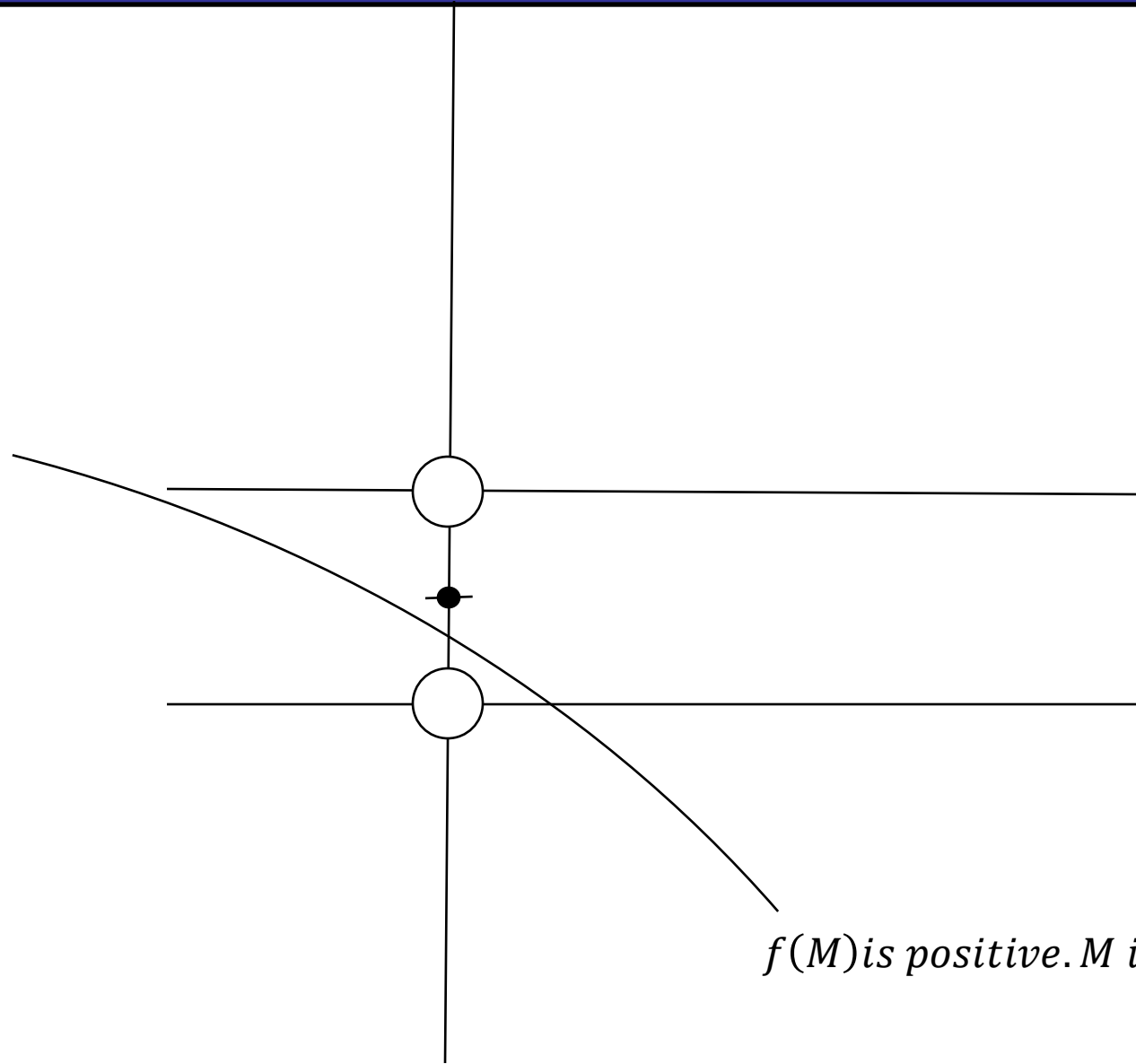


$$x^2 + y^2 = r^2$$
$$x^2 + y^2 - r^2 = 0$$
$$f(x, y) = x^2 + y^2 - r^2$$

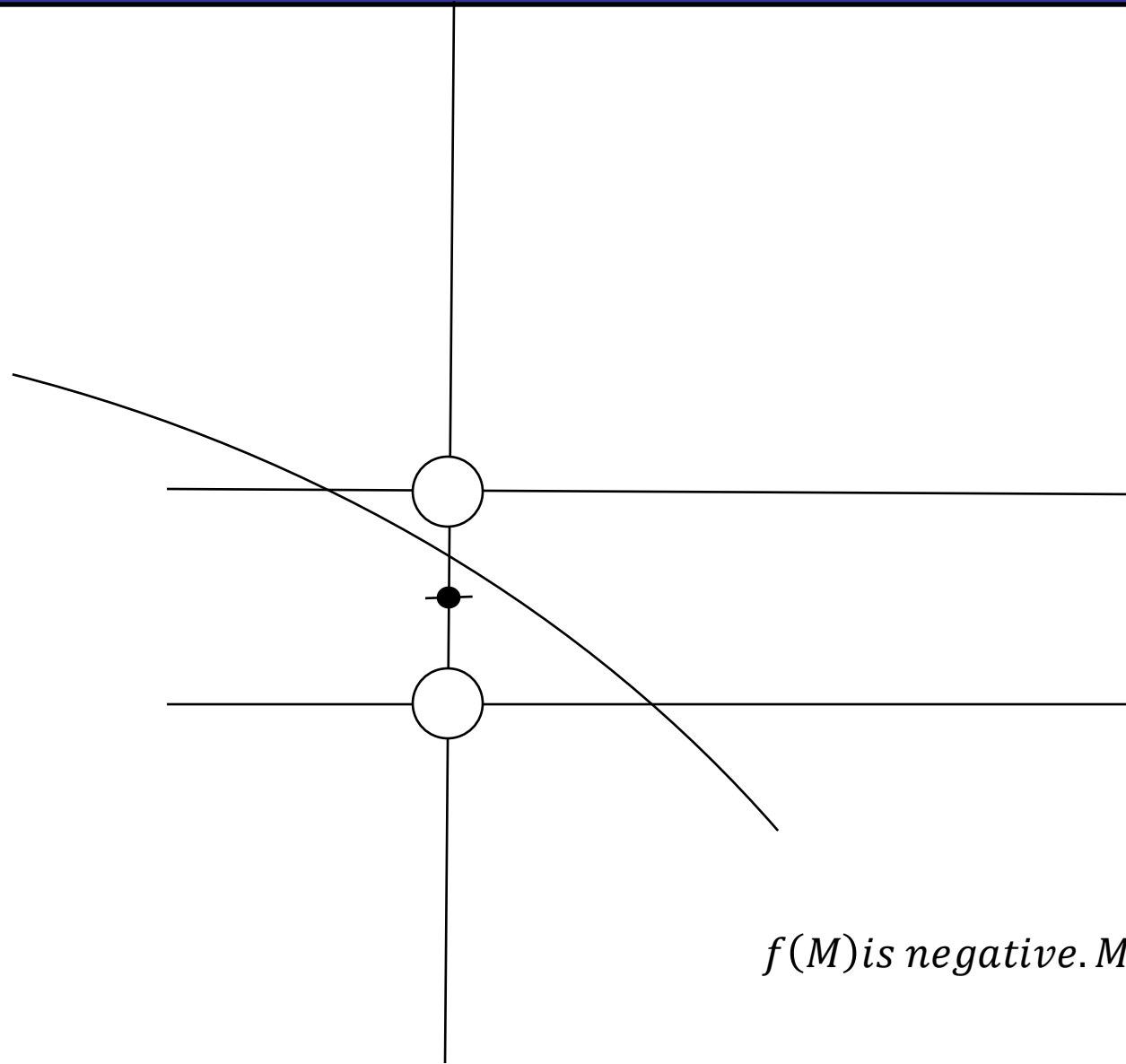


$$\begin{aligned}f(2, 3) &= 0 \\f(2, 4) &= (+)ve \\f(2, 2) &= (-)ve\end{aligned}$$



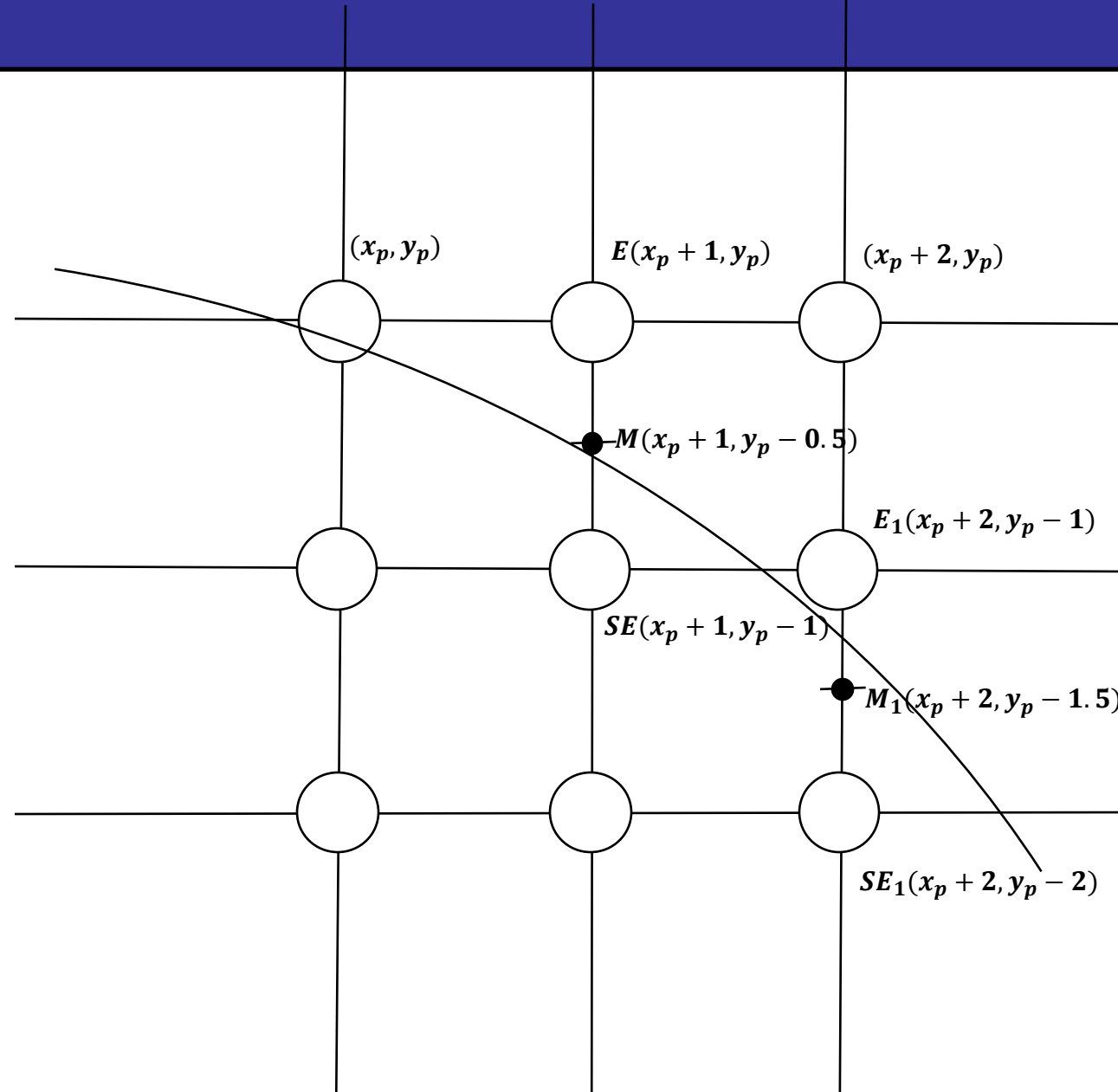


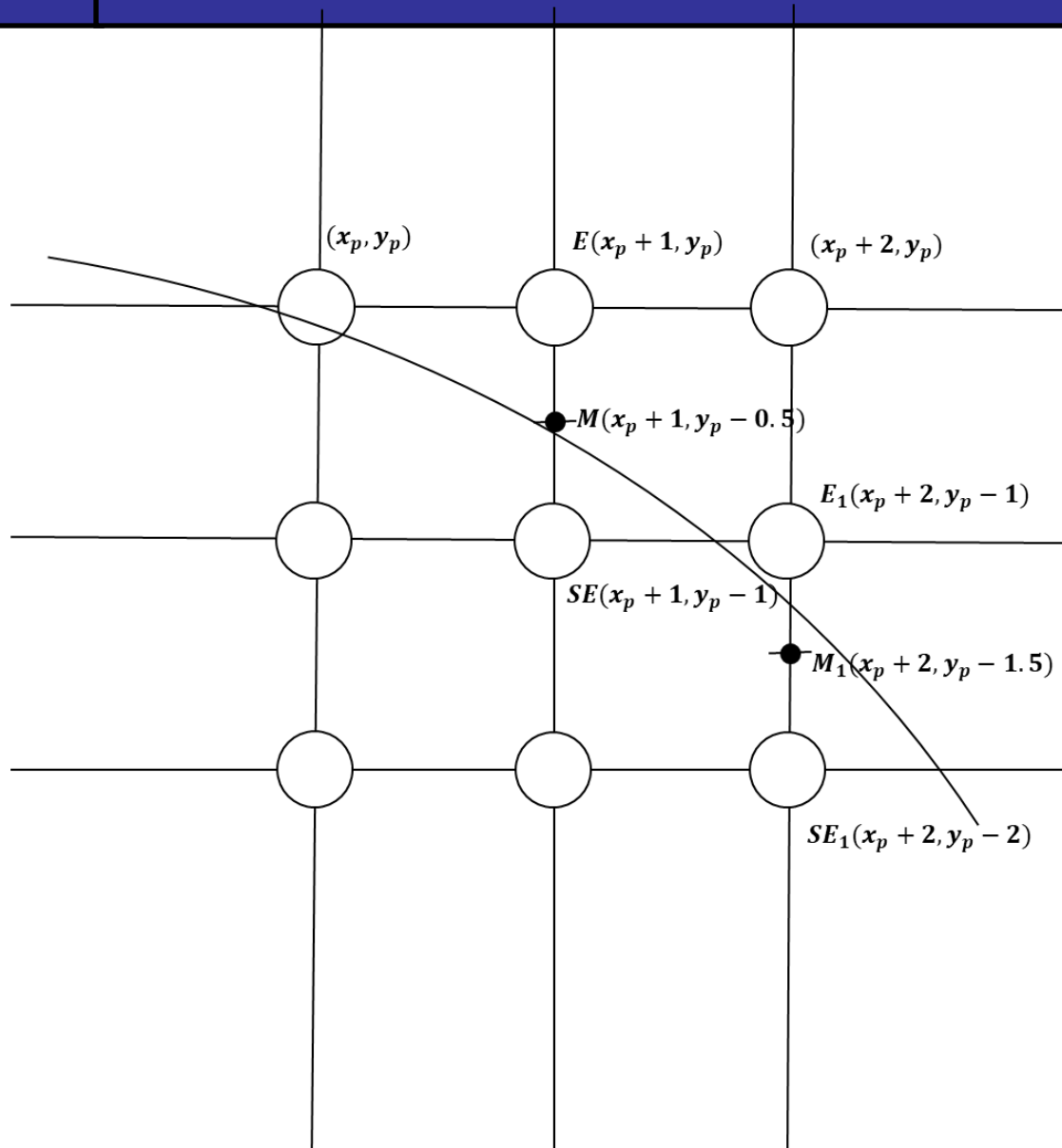
$f(M)$ is positive. M is outside the circle



$f(M)$ is negative. M is inside the circle

$f(M)$	Pixel chosen
$f(M) \geq 0$	Lower
$f(M) < 0$	Upper

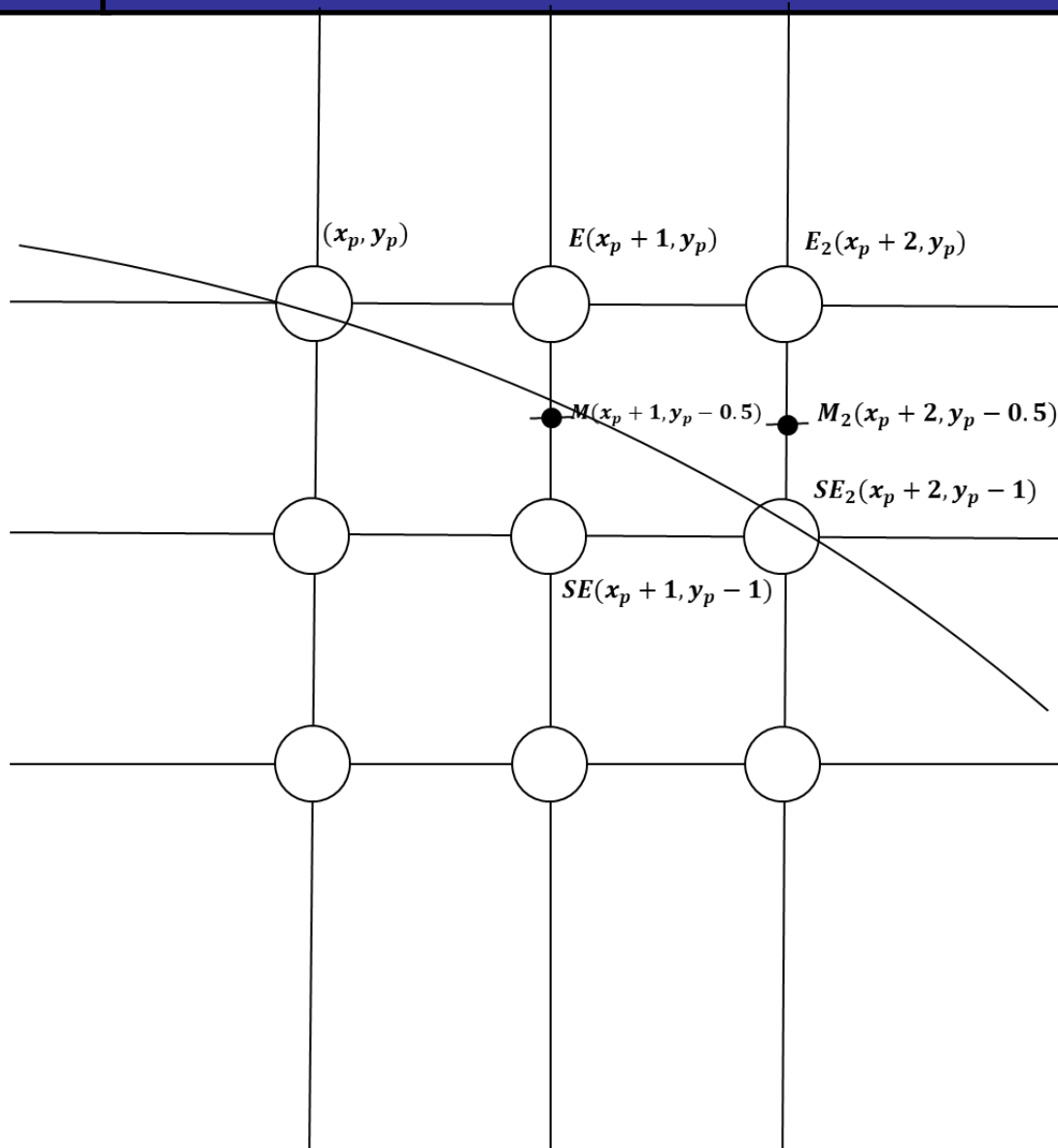




$$\begin{aligned}
 f(M) &= f(x_p + 1, y_p - 0.5) \\
 &= (x_p + 1)^2 + (y_p - 0.5)^2 - r^2 \\
 d &= x_p^2 + 2x_p + 1 + y_p^2 - 2y_p \cdot 0.5 + 0.5^2 - r^2 \\
 &= x_p^2 + 2x_p + 1 + y_p^2 - y_p + 0.25 - r^2 \\
 d &\geq 0, \text{ so } SE \text{ is chosen}
 \end{aligned}$$

$$\begin{aligned}
 f(M_1) &= f(x_p + 2, y_p - 1.5) \\
 &= (x_p + 2)^2 + (y_p - 1.5)^2 - r^2 \\
 d_{\text{new}} &= x_p^2 + 4x_p + 4 + y_p^2 - 2y_p \cdot 1.5 + 1.5^2 - r^2 \\
 &= x_p^2 + 4x_p + 4 + y_p^2 - 3y_p + 2.25 - r^2
 \end{aligned}$$

$$\begin{aligned}
 d_{\text{new}} - d &= 2x_p + 3 - 2y_p + 2 \\
 d_{\text{new}} &= d + 2x_p - 2y_p + 5
 \end{aligned}$$



$$\begin{aligned}
 f(M) &= f(x_p + 1, y_p - 0.5) \\
 &= (x_p + 1)^2 + (y_p - 0.5)^2 - r^2 \\
 d &= x_p^2 + 2x_p + 1 + y_p^2 - 2y_p \cdot 0.5 + 0.5^2 - r^2 \\
 &= x_p^2 + 2x_p + 1 + y_p^2 - y_p + 0.25 - r^2 \\
 d &< 0, \text{ so } E \text{ is chosen}
 \end{aligned}$$

$$\begin{aligned}
 f(M_2) &= f(x_p + 2, y_p - 1.5) \\
 &= (x_p + 2)^2 + (y_p - 0.5)^2 - r^2 \\
 d_{\text{new}} &= x_p^2 + 4x_p + 4 + y_p^2 - 2y_p \cdot 0.5 + 0.5^2 - r^2 \\
 &= x_p^2 + 4x_p + 4 + y_p^2 - y_p + 0.25 - r^2
 \end{aligned}$$

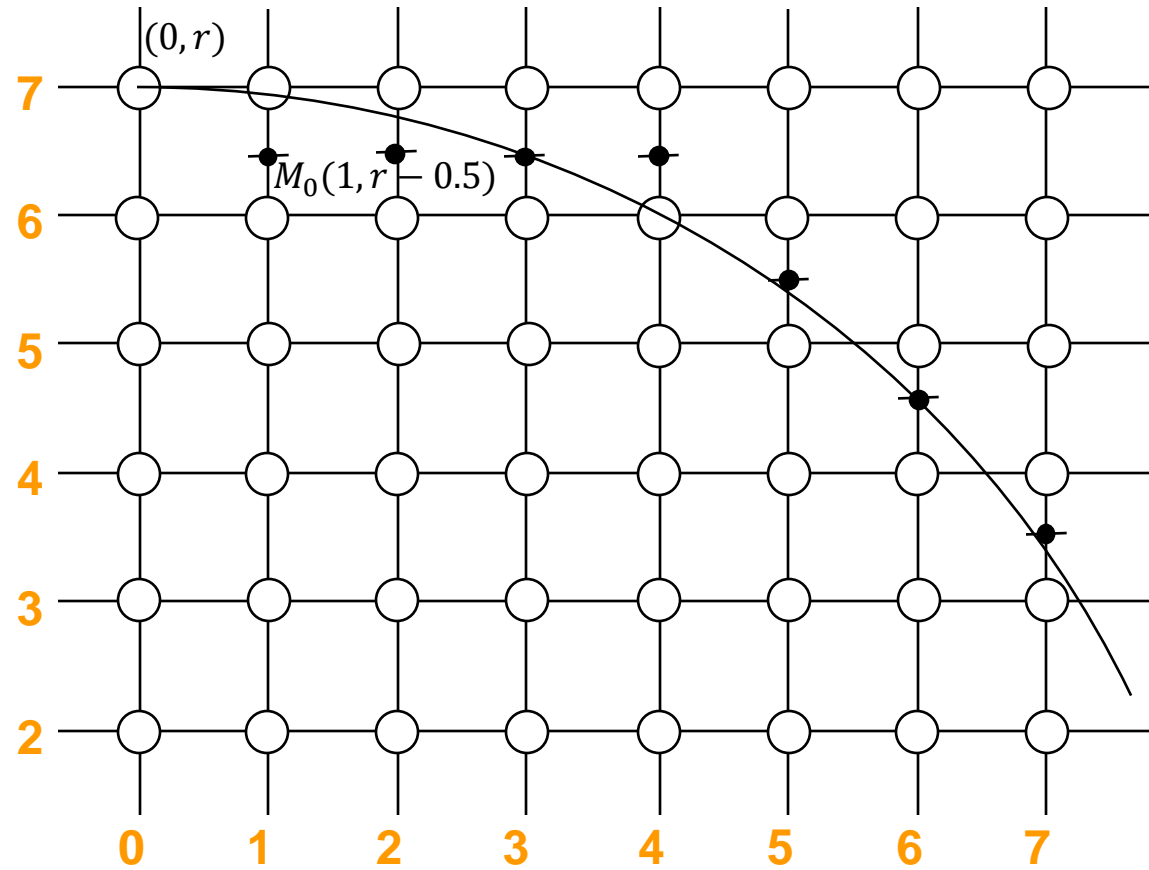
$$\begin{aligned}
 d_{\text{new}} - d &= 2x_p + 3 \\
 d_{\text{new}} &= d + 2x_p + 3
 \end{aligned}$$

Calculate d for 1st column.

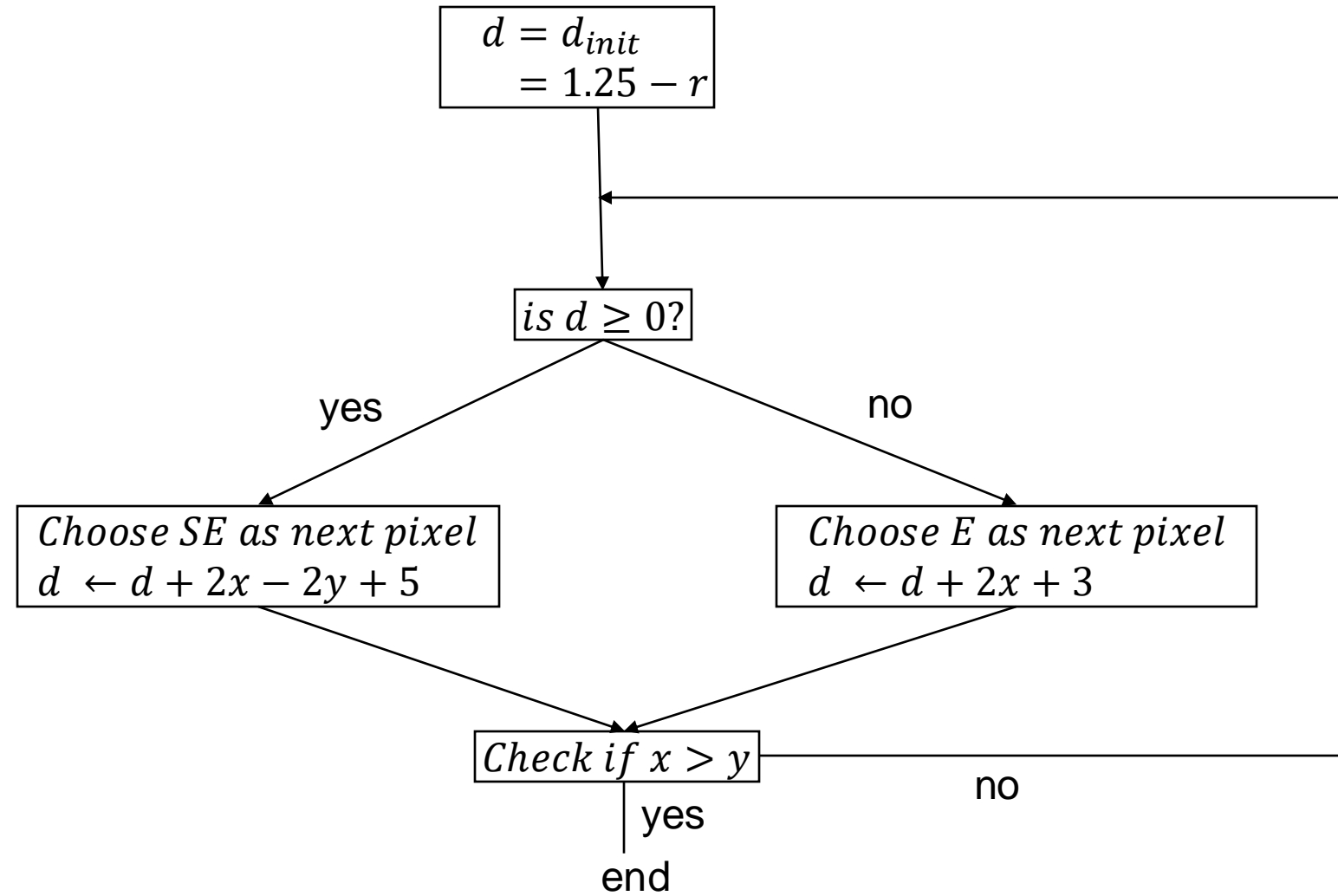
Choose E/SE.

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

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

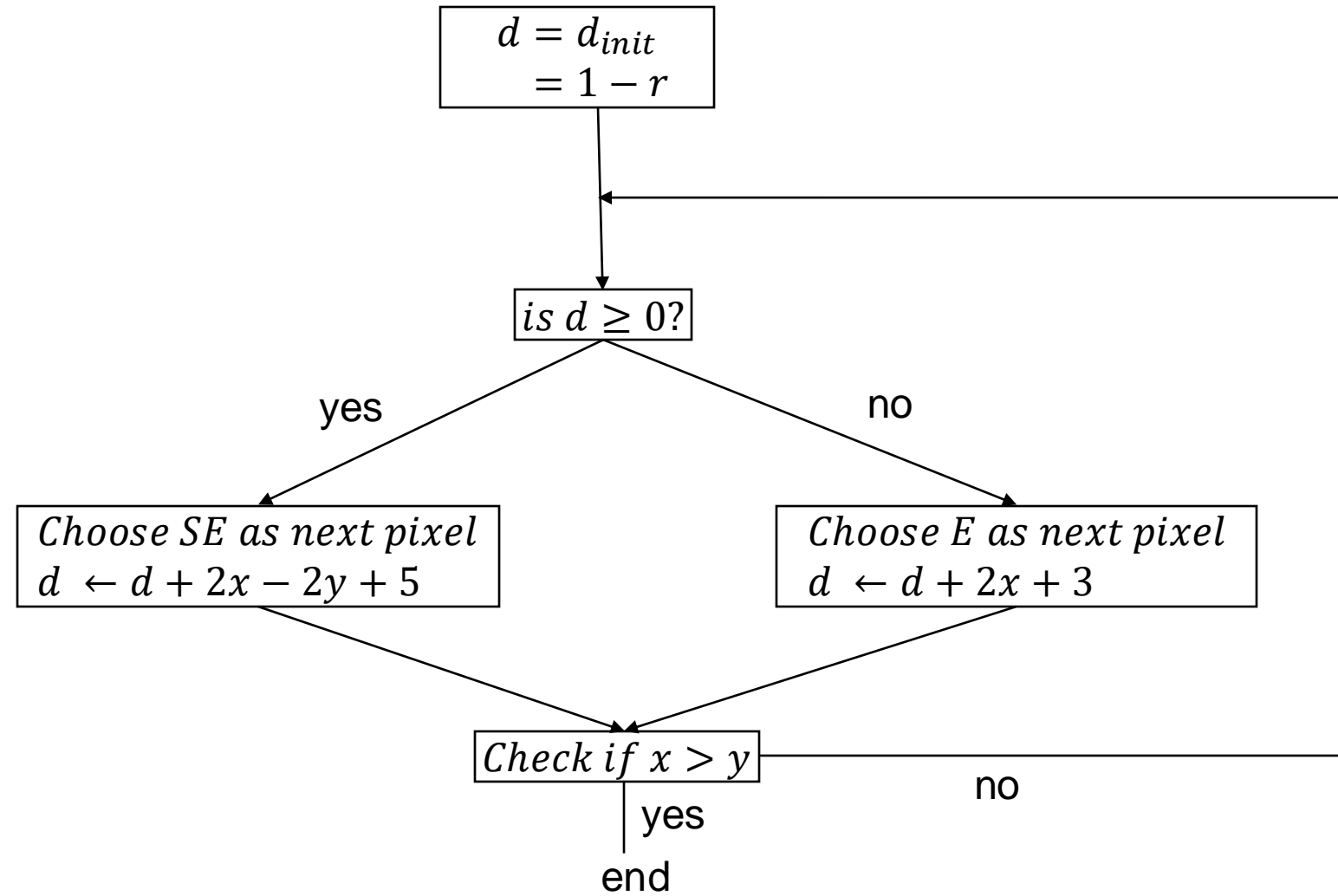


$$\begin{aligned}d_{init} &= f(M_0) \\&= f(1, r - 0.5) \\&= 1^2 + (r - 0.5)^2 - r^2 \\&= 1 + r^2 - r + 0.25 - r^2 \\d_{init} &= 1.25 - r\end{aligned}$$



r	1.25-r	1-r
1	0.25, (+)ve	0, (+)ve
2	-0.75, (-)ve	-1, (-)ve
3	-1.75, (-)ve	-2, (-)ve
4	-2.75, (-)ve	-3, (-)ve
5	-3.75, (-)ve	-4, (-)ve

Using 1-r would be same as using 1.25-r as starting value of d



```
func MidpointCircle(int radius, int value){
    int x, y, d;
    d = 1 - radius;
    x = 0;
    y = radius;
    Circlepoints(x, y, value);
    while (x < y) {
        if (d < 0) {
            //choose E
            d = d + 2*x + 3;
            x = x + 1;
        }
        else {
            //choose SE
            d = d + 2*x - 2*y + 5;
            x = x + 1;
            y = y - 1;
        }
        Circlepoints(x,y, value)
    }
}
```

```
void Circlepoints(int x, int y, int value){  
    WritePixel (x, y, value);  
    WritePixel (y, x, value);  
    WritePixel (y, -x, value);  
    WritePixel (x, -y, value);  
    WritePixel (-x, -y, value);  
    WritePixel (-y, -x, value);  
    WritePixel (-y, x, value);  
    WritePixel (-x, y, value);  
}
```

