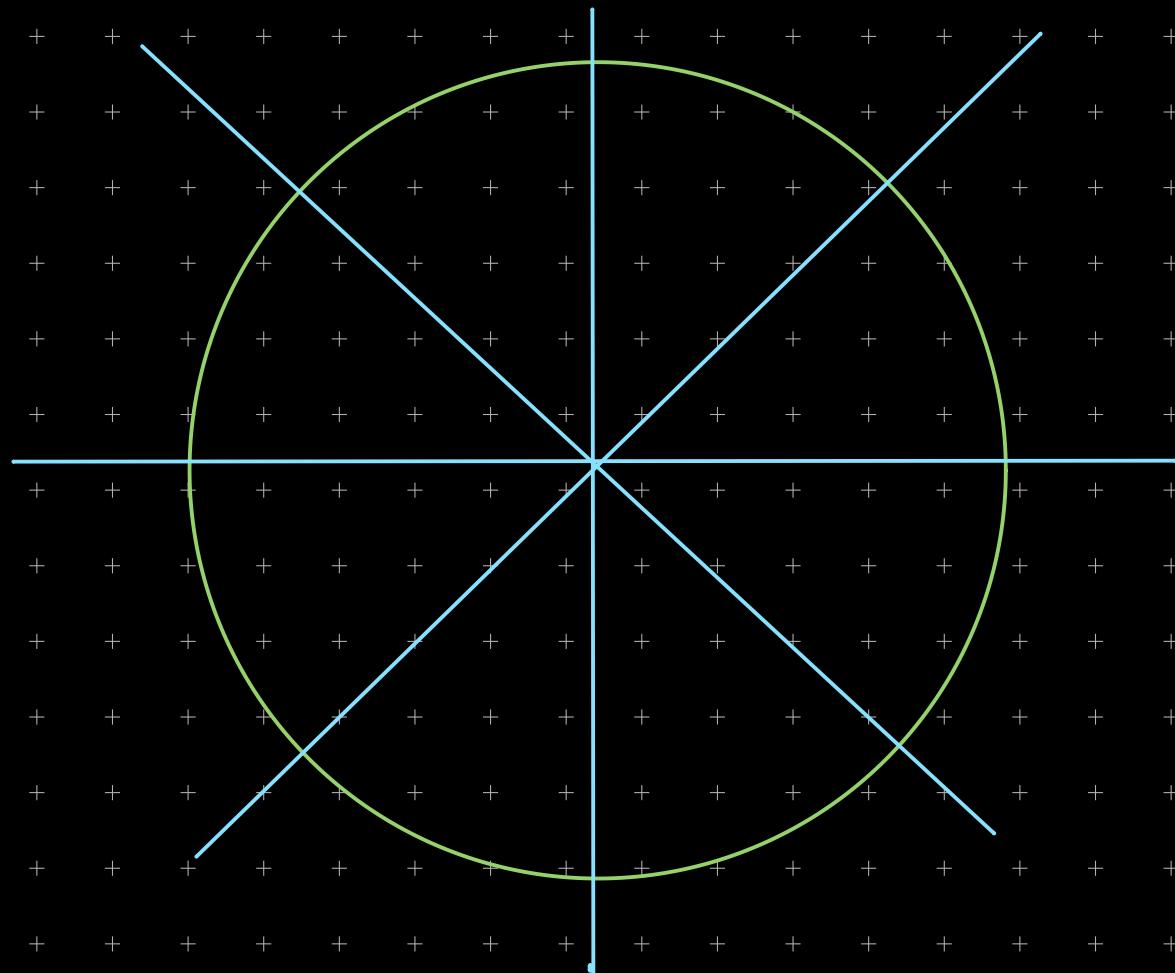


# Midpoint Circle Algorithm



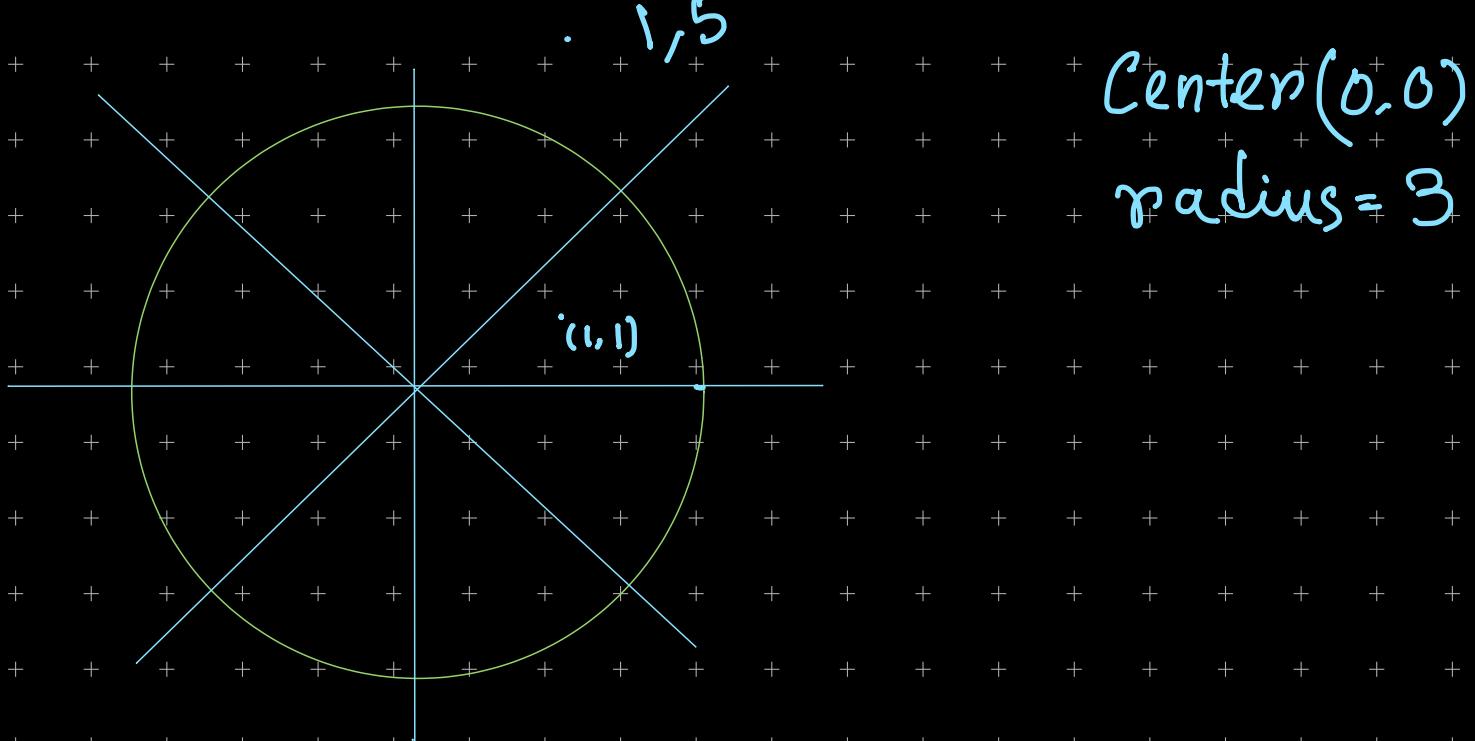
Center =  $(0, 0)$

radius =  $r$

$$x^2 + y^2 = r^2$$

$$\Rightarrow x^2 + y^2 - r^2 = 0$$

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



$$f(x, y) = x^2 + y^2 - 3^2$$

$$f(1, 1) = 1^2 + 1^2 - 3^2 \quad [\text{inside}]$$

$$= -7 > 0$$

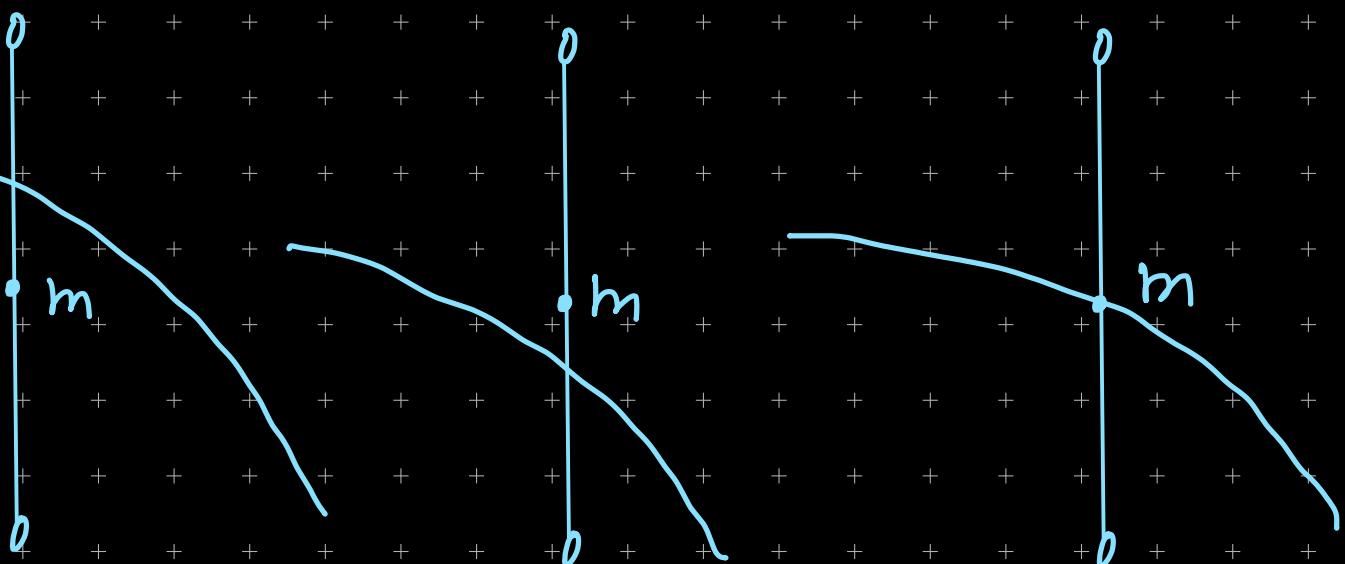
$$f(1, 5) = 1^2 + 5^2 - 3^2$$

$$= 17 > 0 \quad [\text{outside}]$$

$$f(3, 0) = 3^2 + 0^2 - 3^2 \quad [\text{on}]$$

$$= 0$$

There can be three possibilities



$$f(m) < 0$$

Upper

$$f(m) > 0$$

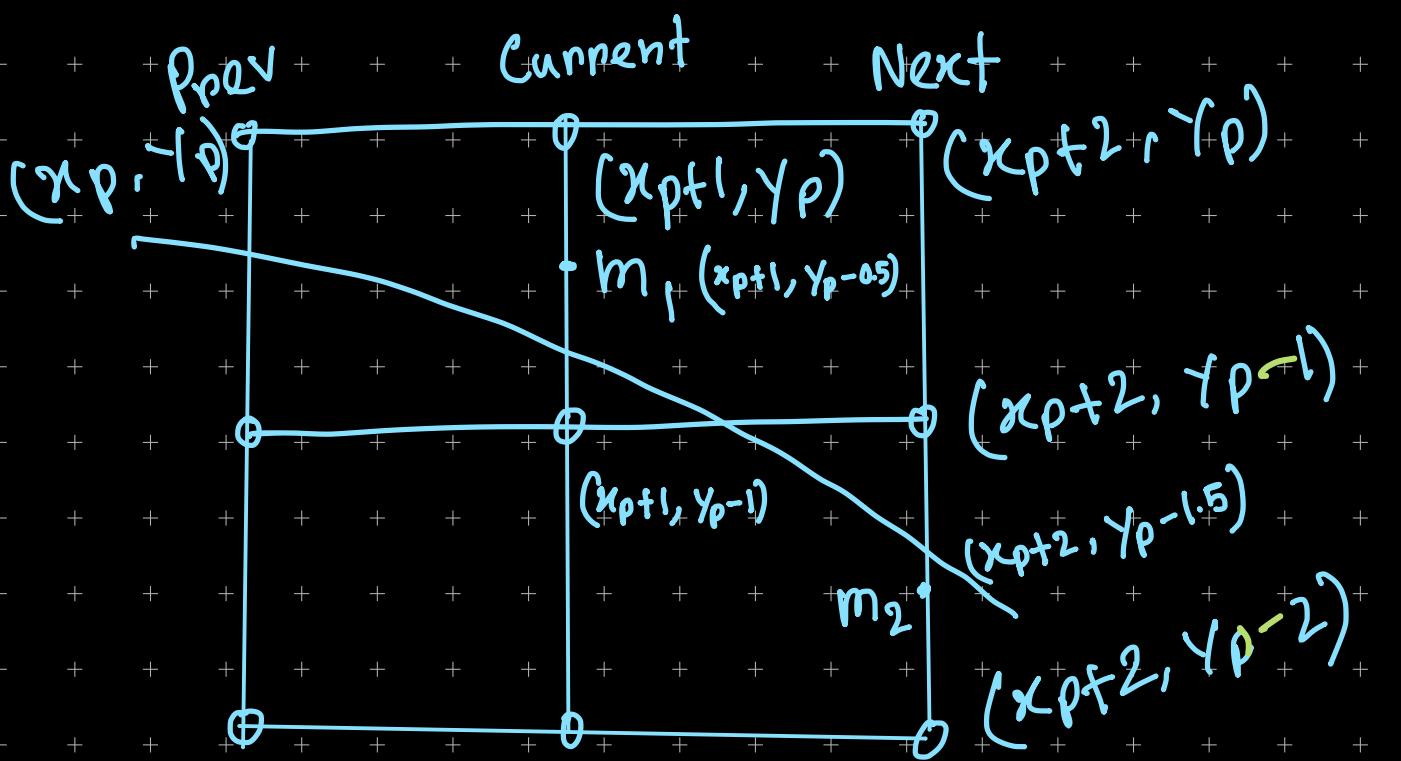
Lower

$$f(m) = 0$$

Lower

E →

S



if the current step pixel is SE. Then what is the value of d in the next step?

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

$$\begin{aligned}
 d_{current} &= f(m_1) = f(x_{pt1}, y_p - 0.5) \\
 &= (x_{pt1})^2 + (y_p - 0.5)^2 - r^2 \\
 &= x_p^2 + 1 + 2x_p + y_p^2 + 0.25 - y_p - r^2
 \end{aligned}$$

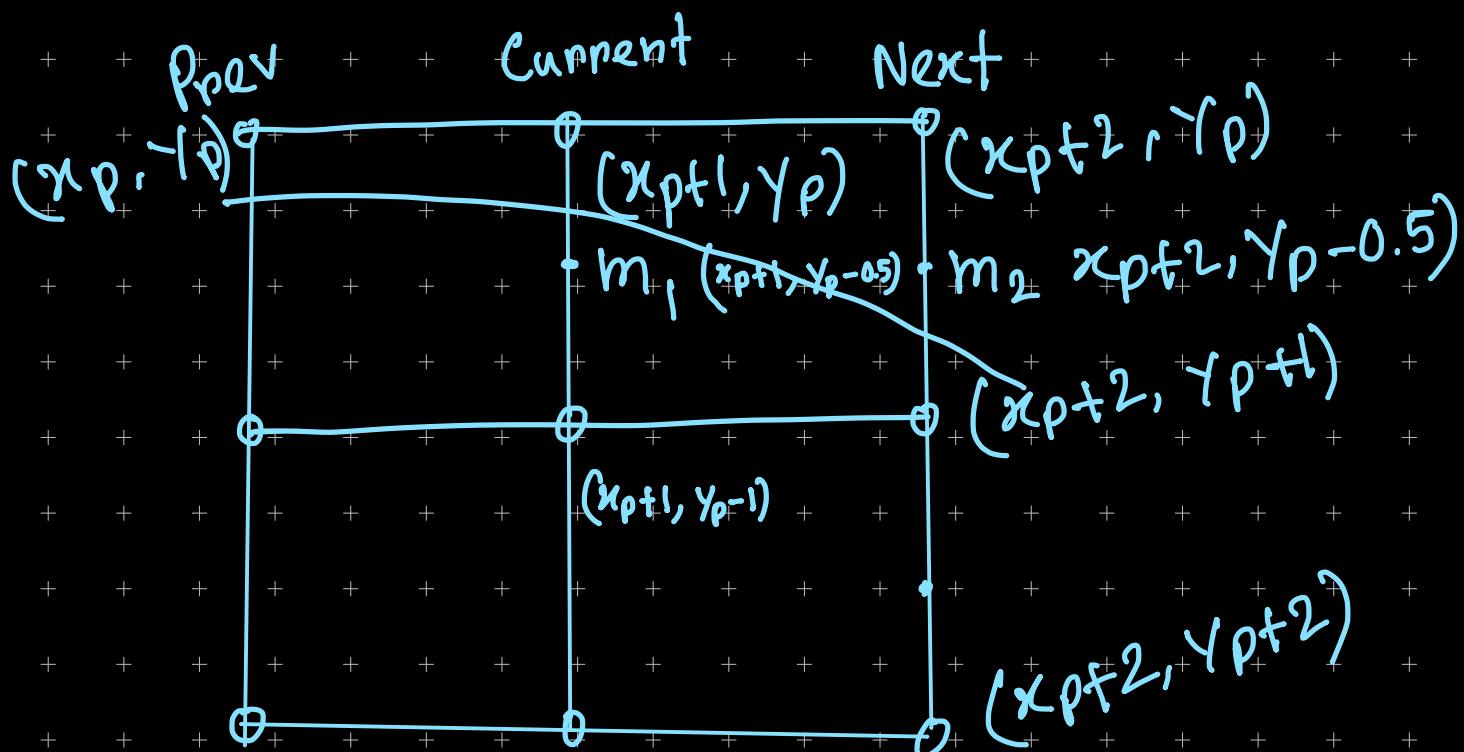
$$\begin{aligned}
 d_{next} &= f(m_2) = f(x_{pt2}, y_{p-1.5}) \\
 &= (x_{pt2})^2 + (y_{p-1.5})^2 - r^2 \\
 &= x_p^2 + 4 + 4x_p + y_p^2 + 2.25 - 3y_p - r^2
 \end{aligned}$$

$$d_{\text{next}} - d_{\text{current}} = 2x_p + 3 - 2y_p + 2$$

$$\therefore d_{\text{next}} = d_{\text{current}} + 2x_p - 2y_p + 5$$

$$\Rightarrow d = d + 2x_p - 2y_p + 5$$

if the current step pixels is  $E$ . Then  
what is the value of  $d$  in the next step?



$$d_{\text{current}} = f(m_1) = f(x_p + 1, y_p - 0.5)$$

$$= (x_p + 1)^2 + (y_p - 0.5)^2 - r^2$$

$$d_{\text{next}} = f(m_2) = f(x_p + 2, y_p - 0.5)$$

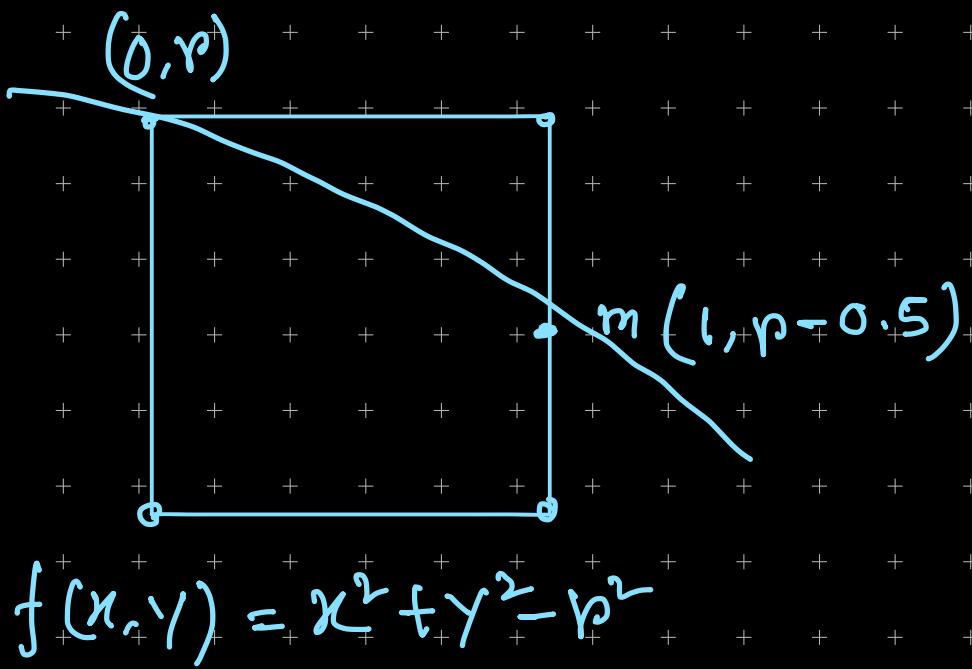
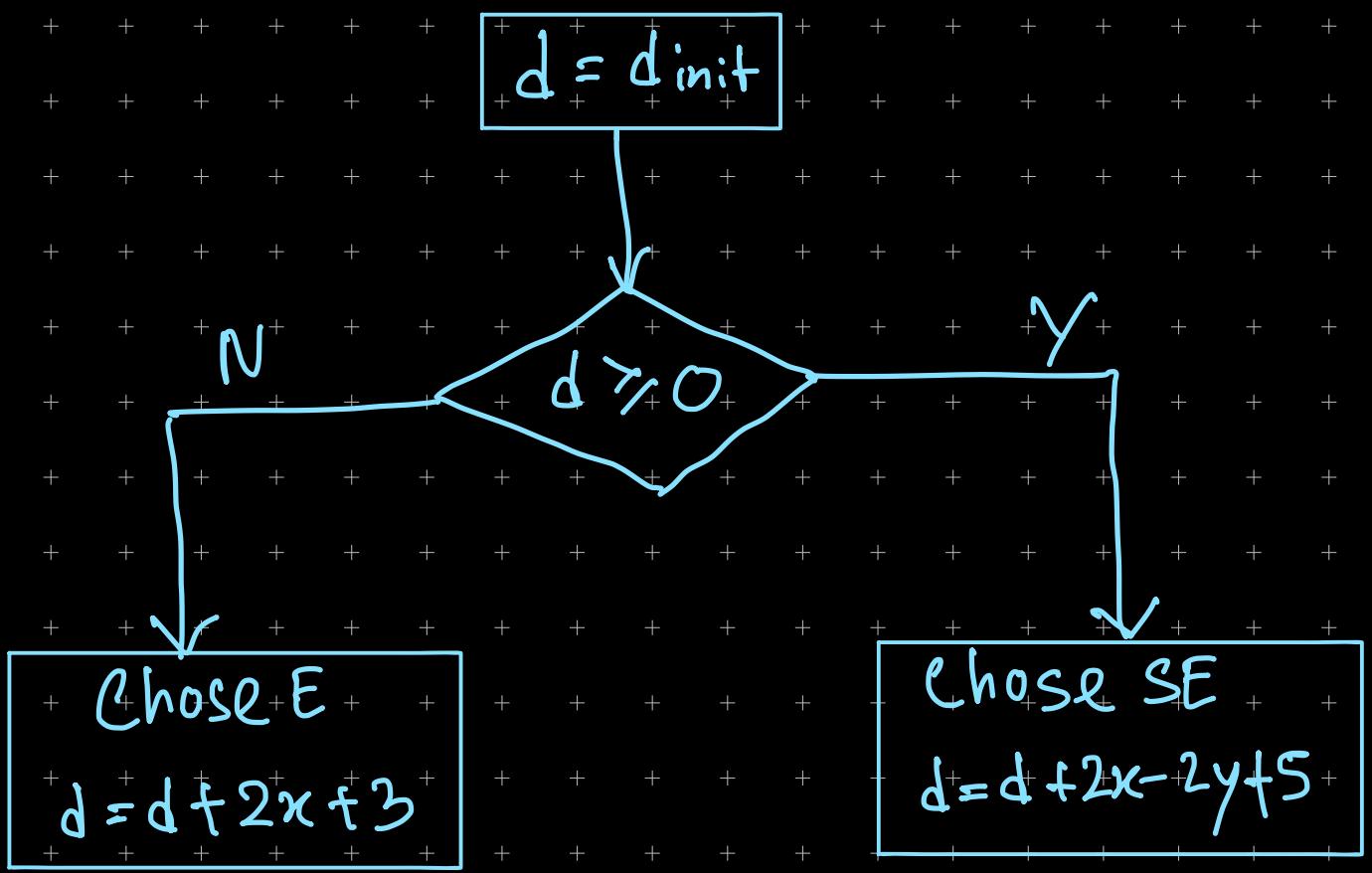
$$= (x_p + 2)^2 + (y_p - 0.5)^2 - r^2$$

$$= x_p^2 + 4 + 4x_p + y_p^2 + 0.25 - y_p - r^2$$

$$d_{\text{next}} - d_{\text{current}} = 2x_p + 3$$

$$\therefore d_{\text{next}} = d_{\text{current}} + 2x_p + 3$$

$$\Rightarrow \boxed{d = d + 2x_p + 3}$$



$$d_{init} = f(l, r - 0.5) = l^2 + (r - 0.5)^2 - r^2$$

$$= l^2 + r^2 - 0.25 - r^2$$

$$\Rightarrow d_{init} = l \cdot 25 - r$$

r

$$d_{init} = 1.25 - r$$

$$d_{init} = 1 - r$$

1

0.25 (SE)

2

-0.75 (E)

3

-1.75 (E)

4

-2.75 (E)

0 (SE)

-1 (E)

-2 (E)

-3 (E)

So there is no matter if its  $d_{init} = 1 - r$

$$d = 1 - r$$

N

Y

$$d > 0$$

Choose E  
 $d = d + 2x + 3$

Choose SE  
 $d = d + 2x - 2y + 5$

Y

N

check  $x > y$

Y

Finish

~~#~~ Find out the pixels of a circle where  
Center  $(0,0)$  and radius = 15

# Zone -1+

χ

7

d

E/SE+

# update

# pixel

1

15

100

E + E

$$\begin{array}{r} - \\ + \\ \hline - \end{array}$$

$$(0, 15)$$

2

15

+

+  
S

+  
1  
+  
-18

$$(2, 15)$$

3

+ 13

S + F

- 18

$$(3, 15)$$

4

+

+  
+  
+

+  
-  
+