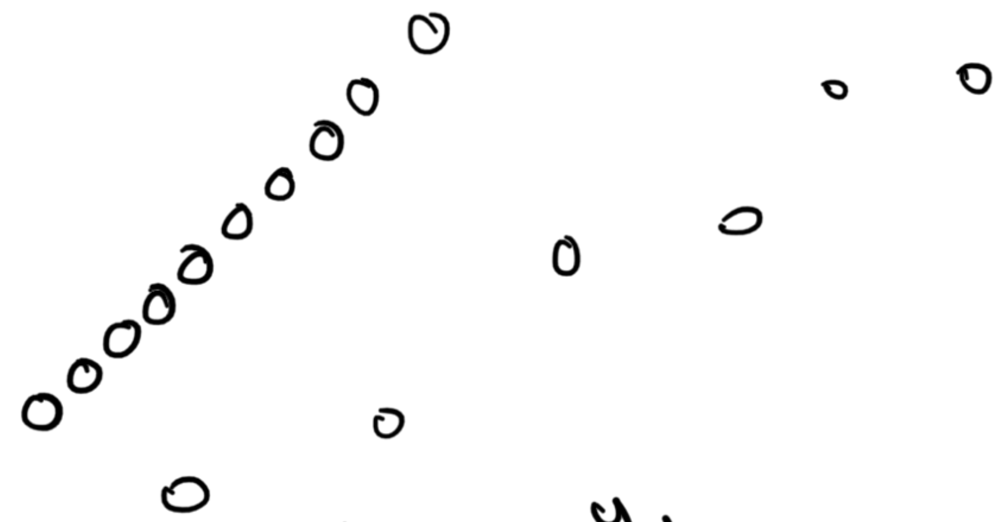
Week 2

8 way Symmetry

midpoint Problems!

$m > 1$



$(\overset{x_0}{30}, \overset{y_0}{-20})$ to $(\overset{x_1}{-90}, \overset{y_1}{40})$

$(-90, 40)$ $(30, -20)$

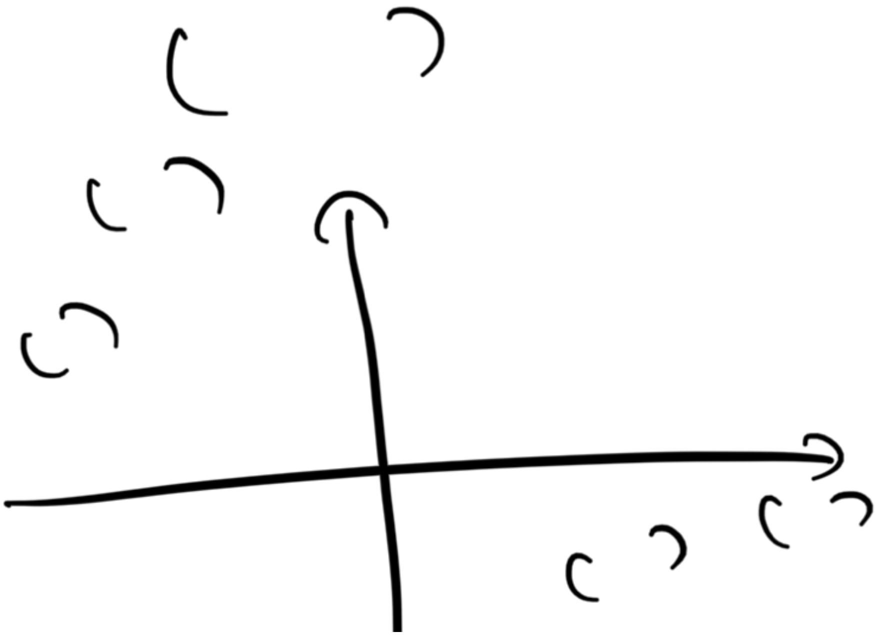
$x{+}{+}$

-20

$40{+}{+}$

$y{-}{-}$

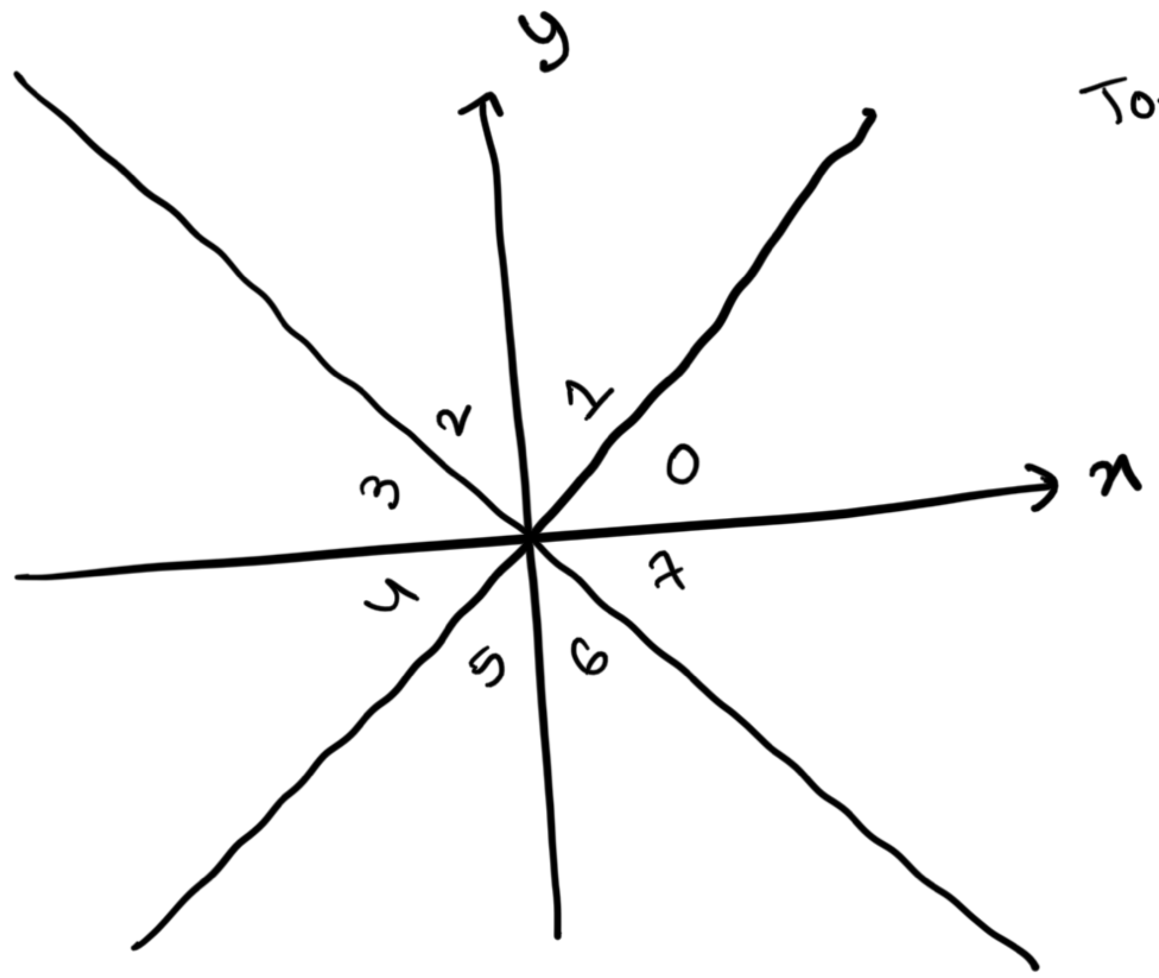
$x{+}{+}$



$x{+}{+}$

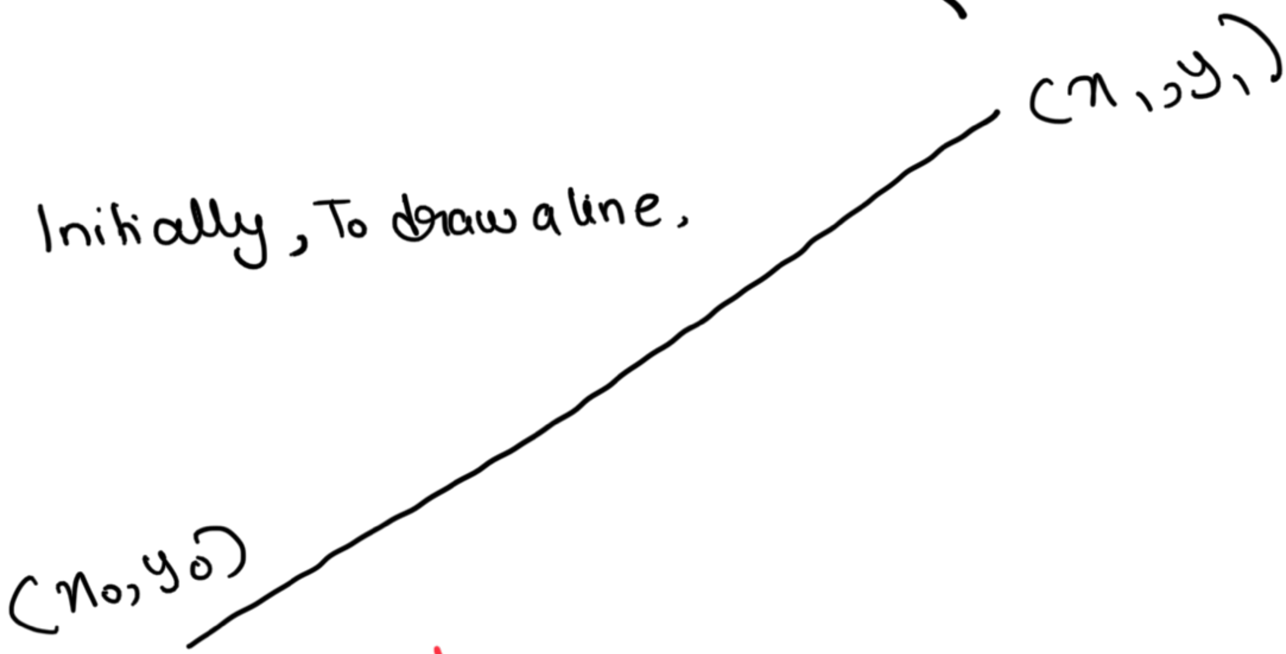
$y{+}{+}$

Eight-way Symmetry



Total 8 zones.

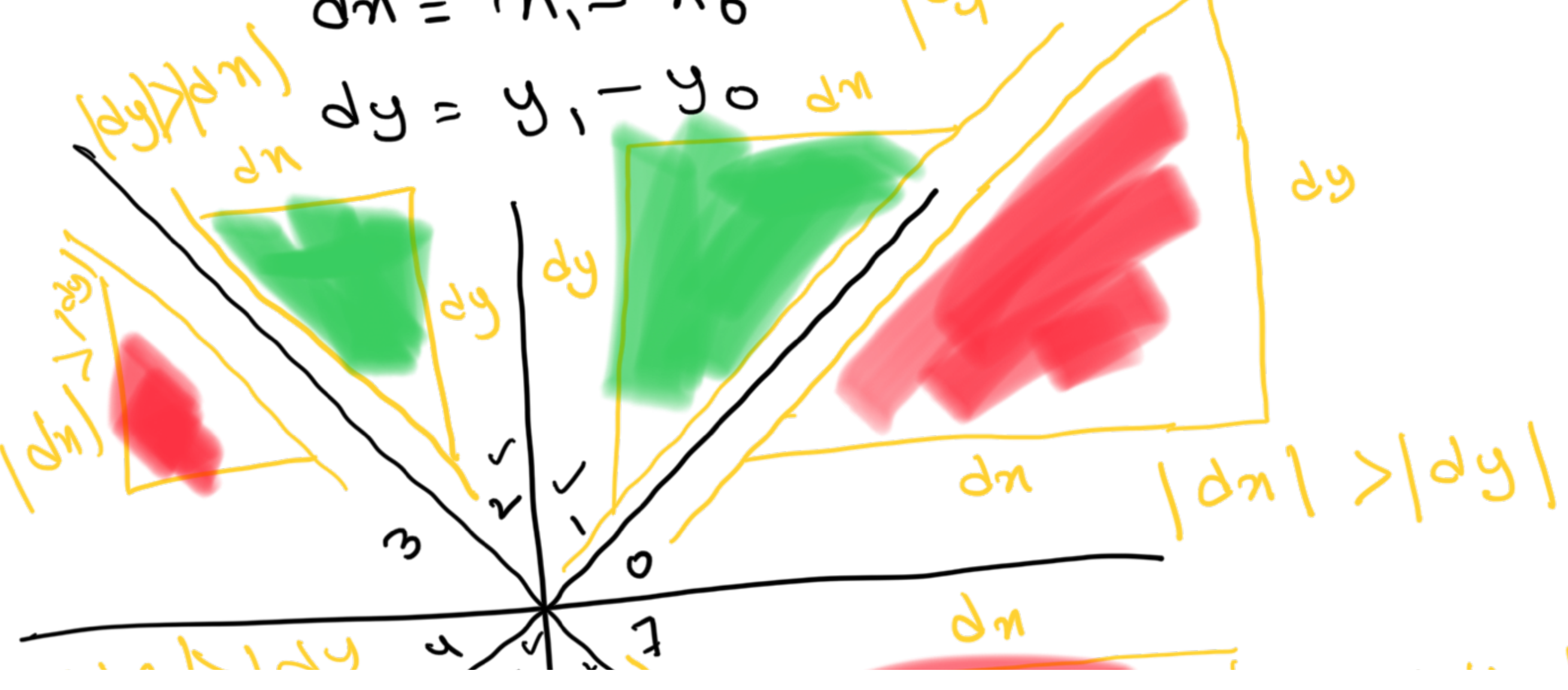
Initially, To draw a line,

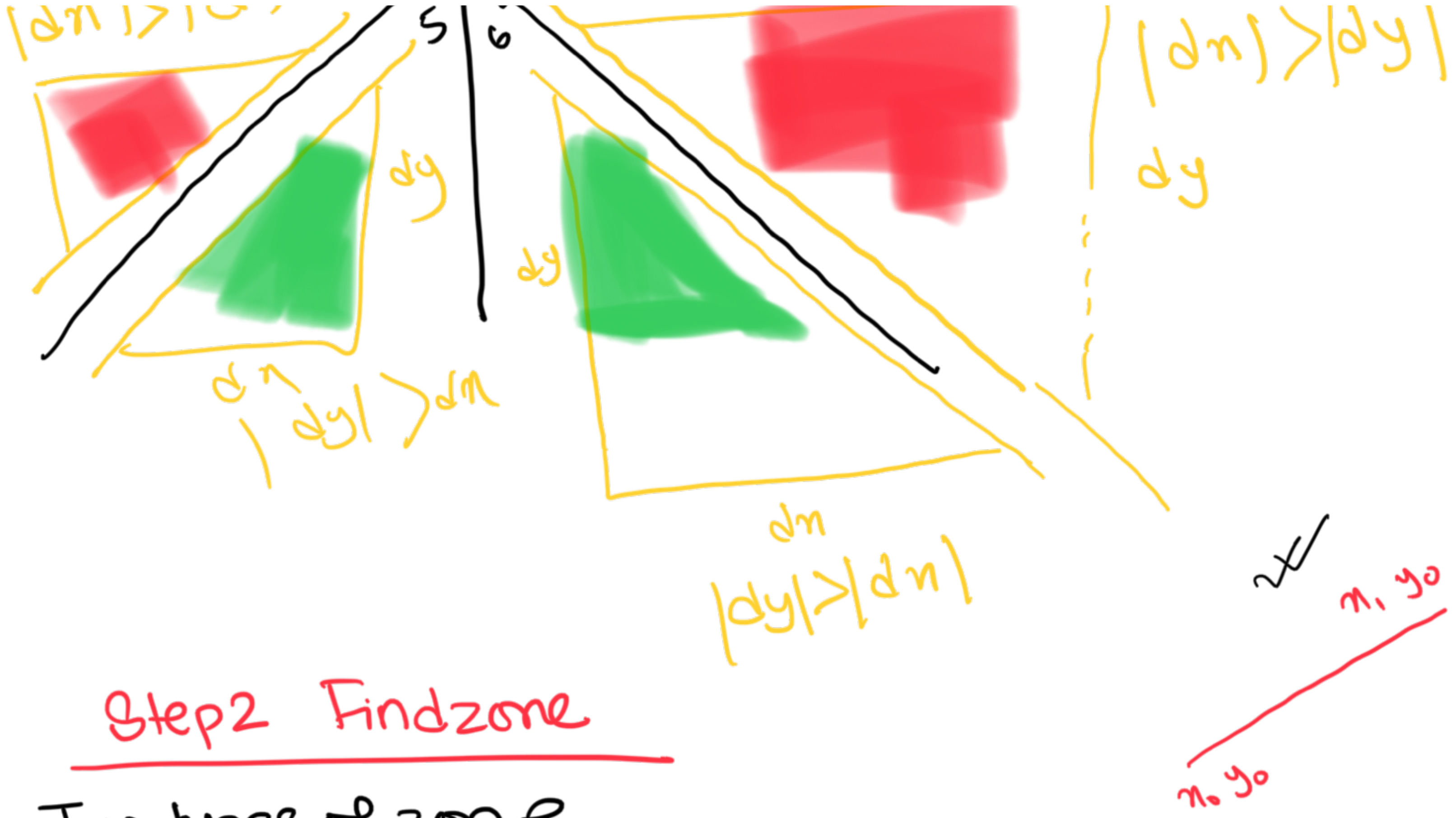


Step 1 Find dx and dy

$dx = x_1 - x_0$

$dy = y_1 - y_0$





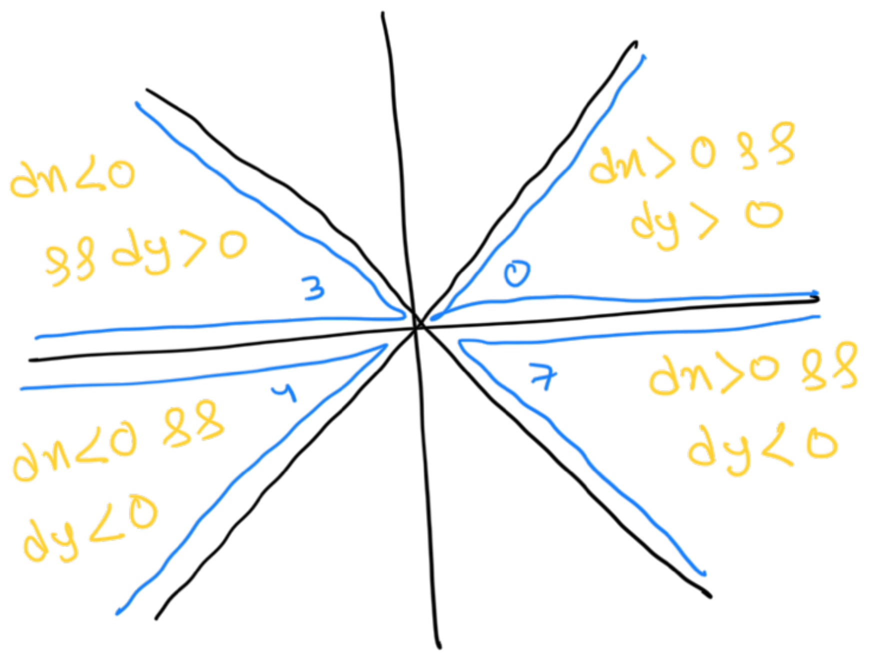
Step2 Findzone

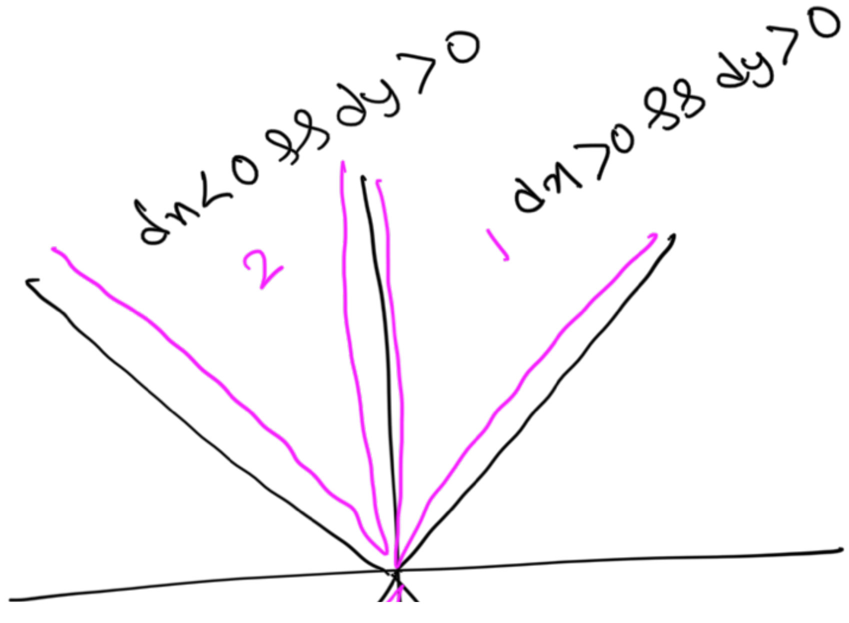
Two types of zone

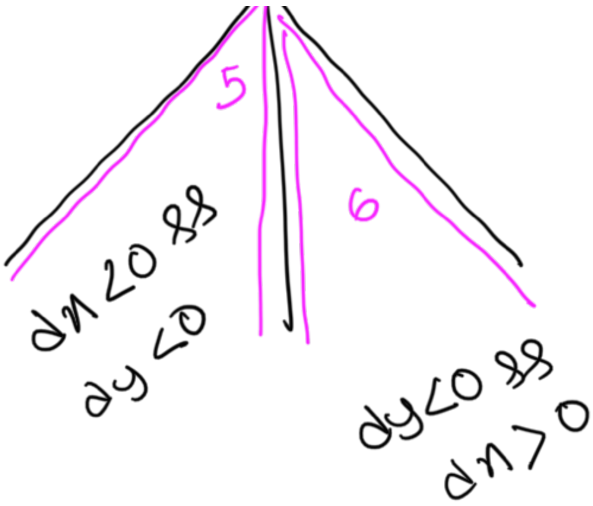
zone 1, 2, 6, 5 — |dy| > |dx|

zone 0, 7, 3, 4 — |dx| > |dy|

```
findzone (int x0, int y0, int x1, int y1)
    int dx = x1 - x0
    int dy = y1 - y0
    if (|dx| > |dy|) {        //zone 0,3,4,7
        if (dx>=0 && dy>=0)
            zone 0
        elif (dx<0 and dy>=0)
            zone = 3
        elif (dx>=0 and dy<=0)
            zone = 7
        elif (dx<=0 && dy<=0)
            zone = 4
    }
    else:                     //1,2,5,6
        if (dx>=0 && dy>=0)
            zone=1
        elif (dx<=0 and dy>=0)
```







zone=2

elif (dx >= 0 && dy <= 0)

zone=6

elif (dx <= 0 && dy <= 0)

zone=5

For example: (−30, −10) to (−10, 30)

$dx = -10 - (-30) = 20$. $dx > 0$

$dy = 30 - (-10) = 40$. $dy > 0$

( )

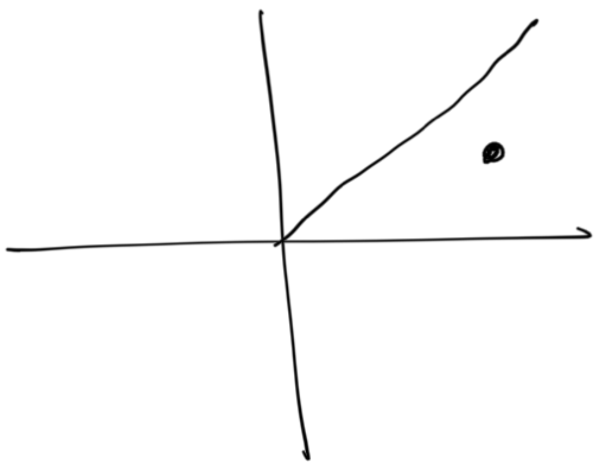
$dy > dx$

zone = 1 ←   ↓ ending

Step 3 Convert to zone 0 (int x, y, zone)

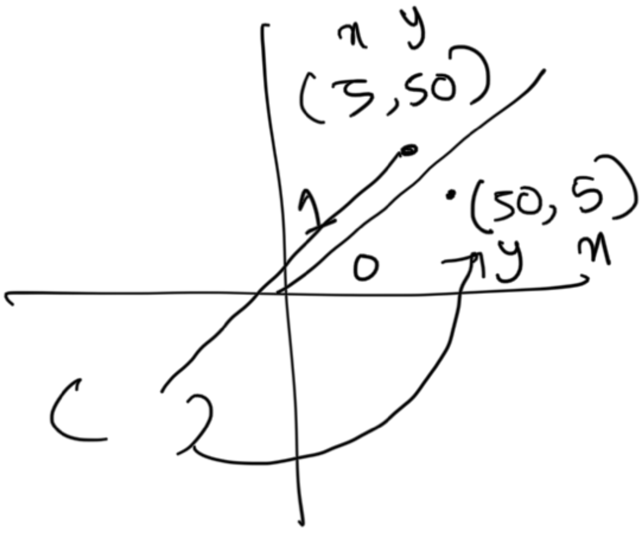
$X = 0$

$Y = 0$



if (zone == 0)

$X = x, \ Y = y$



if (zone == 1)

$X = y, \ Y = x$

if (zone == 2)

$X = y$

$Y = -x$

if (zone == 3)

$X = -x$

$Y = y$

if (zone == 4)

$X = -x$
$Y = -y$

if (zone == 5)

$X = -y$
$y = -x$

if (zone == 6)

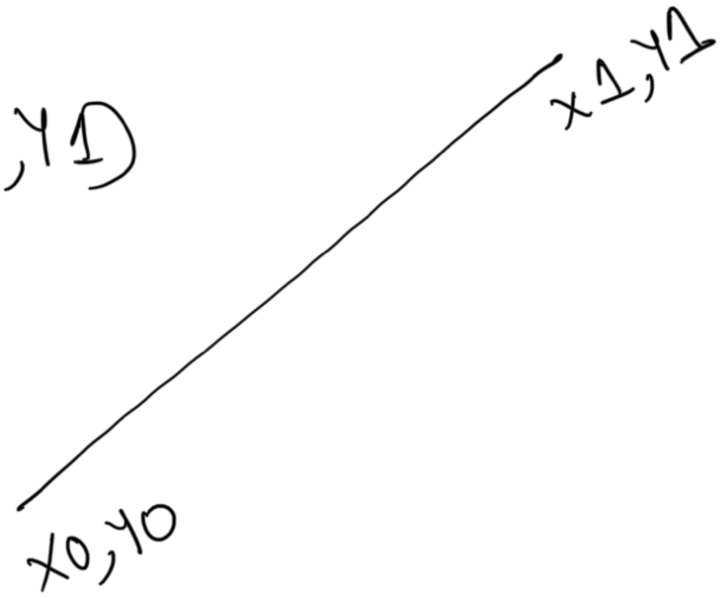
$X = -y$
$Y = x$

if (zone == 7)

$X = x$
$Y = -y$

New Coordinate,

(X0, Y0) (X1, Y1)



Step 4 Apply Midpoint line Algorithm

midpoint (X0, Y0, X1, Y1)

$dx = X1 - X0$

$dy = Y1 - Y0$

$D = 2 * dy - dx$

$DNE = 2 * (dy - dx)$

DE = 2 * dy

ne=0

```
x = X0 , y = Y0
while (x <= X1) {
    Draw(x, y);
    x++;
    if (D < 0) {
        D = D + DE;  }              // E
    else {   D = D + DNE; }
        y++;
    }
} end
```

Step 5   zeroToOriginalZone(zone, x, y)

```
x = 0
y = 0
if (zone == 0)
    x = X   y = Y
if (zone == 1)
    x = Y
    y = X
if (zone == 2)
    x = -Y
    y = X
if (zone == 3)
    X = -x
    Y = y
if (zone == 4)
    X = -x
```

Step 3
OriginalZoneToZero

x = y , y = x

x = -x

x = -x

y = y

x = -x
y = -y

$y = -y$

if (zone == 5)

$x = -y$

$y = -x$

if (zone == 6)

$x = y$

$y = -x$

if (zone == 7)

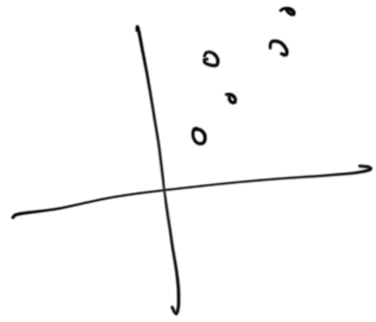
$x = x$

$y = -y$

Overall Step:

Two coordinates given:

1. (I) Find Δx, Δy
2. (II) Find zone with conditions.
3. (III) Convert (x, y) to zone 0
4. (IV) Midpoint line Algorithm.
5. (V) Convert to Original zone.



Example

$(-10, -20)$ to $(-20, 70)$

$x_0 \quad y_0 \qquad x_1 \quad y_1$

Step1

$dx = -20-(-10) = -10 \quad dx<0$

$dy = 70 - (-20) = 90 \quad dy > 0$

$dy > dx \qquad |dy| > |dx|$

$dx <= 0 \ \&\& \ dy >= 0$

Step2

Zone = 2

$(-10, -20) \quad (-20, 70)$

Step3

	$x = y, \ Y = -x$
$(-10, -20)$	$(-20, 10)$
$(-20, 70)$	$(70, 20)$
$x_0 \quad y_0$	$x_1 \quad y_1$

Step4

$dx = 70 + 20 = 90$

$dy = 20 - 10 = 10$

$\rightarrow D = 2 \times 10 - 90 = -70$

$DNE = 2 \times (10 - 90) = -160$

$DE = 2 \times 10 = \underline{20}$

$x = -20, \quad y = 10$

$\overset{-20}{x} < \overset{70}{x1} \leftarrow$ ① pixel $(-20, 10)$

$\leftarrow x = -19$

$// -70 < 0$

$D < 0$

$d = -70 + 20 = -50$

② pixel $(-19, 10)$

$x = -18$

$-50 < 0 \quad // E$

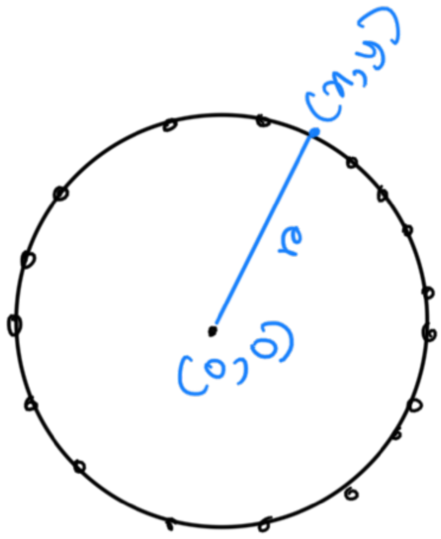
$d = -50 + 20$

$= -30$

③ pixel $(-18, 10)$

Zone 0	zone2 $(-y, x)$
$(-20, 10)$	$(-10, -20)$
$(-19, 10)$	$(-10, -19)$
$(-18, 10)$	$(-10, -18)$

Midpoint Circle



$$r = \sqrt{(x-0)^2 + (y-0)^2}$$

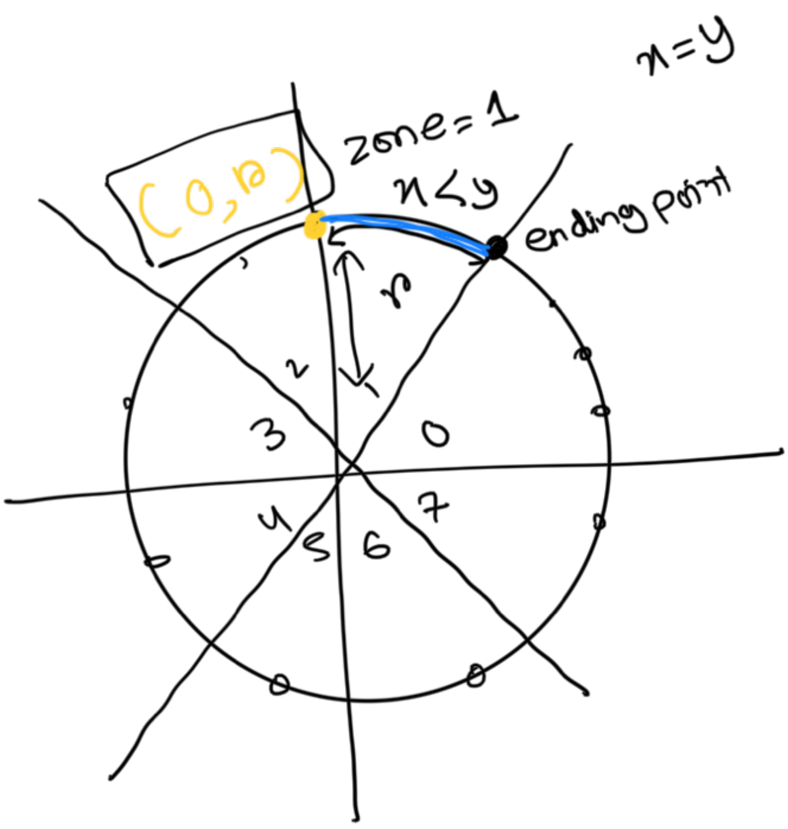
$$r^2 = x^2 + y^2$$

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

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

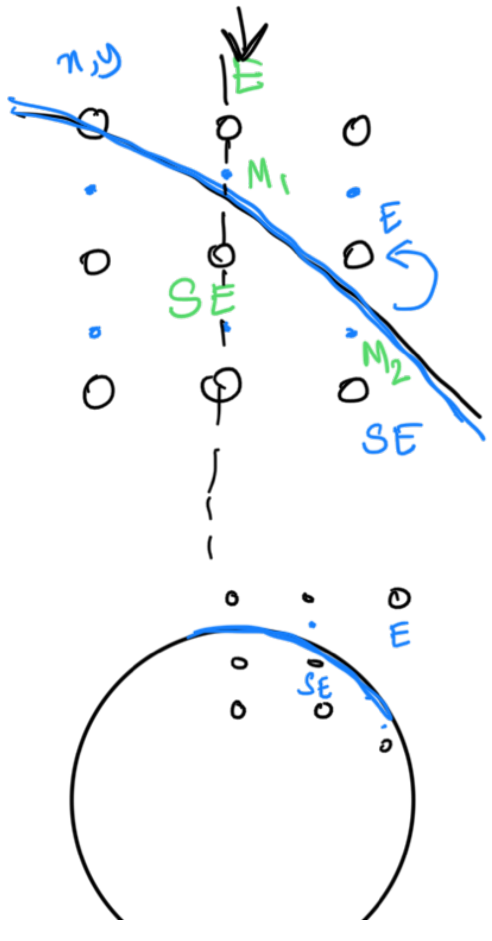
If points are on the boundary of circle

$$f(x,y) = 0$$



- arc length same
- equally divided into sector

Zone 1



If midpoint outside the circle

$f(x,y) > 0$

Choose Lower Pixel / SE

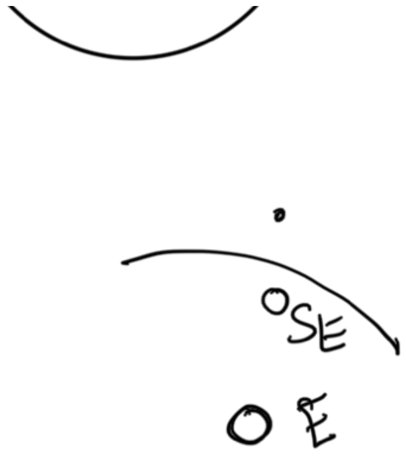
If midpoint is inside the circle

Choose upper Pixel / E

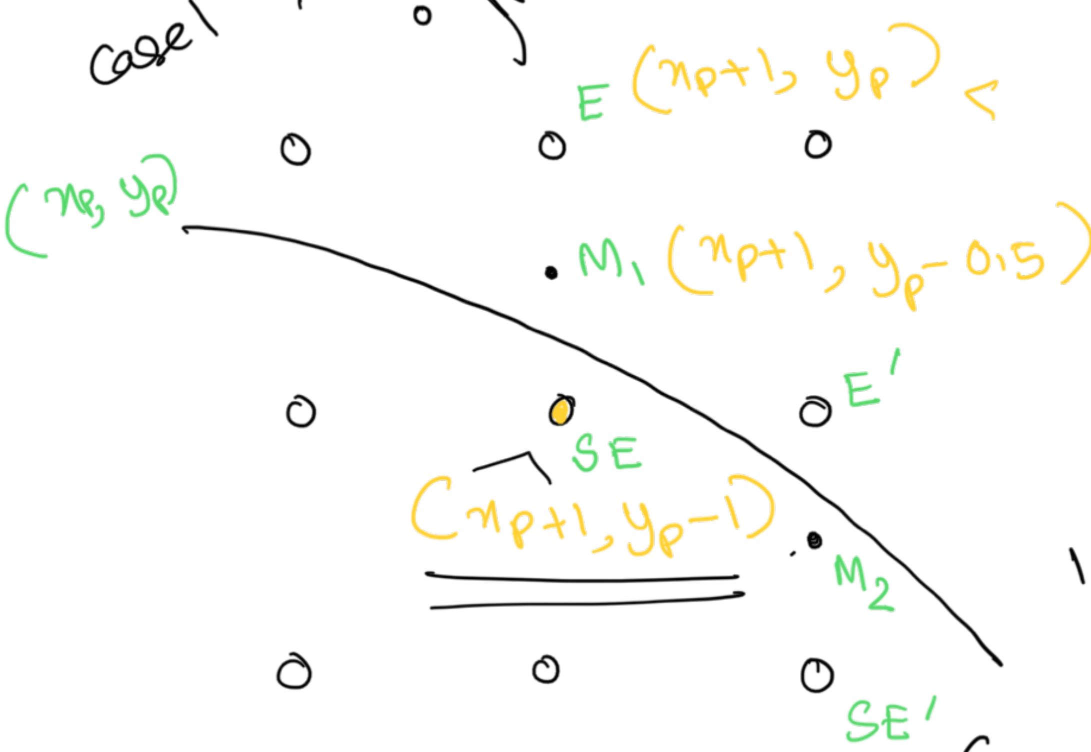
$f(x,y) < 0$

$f(M)$	Pixel
$f(M) \geq 0$	Lower Pixel (SE)

$f(M) \le 0$ Upper Pixel (E)



Case I



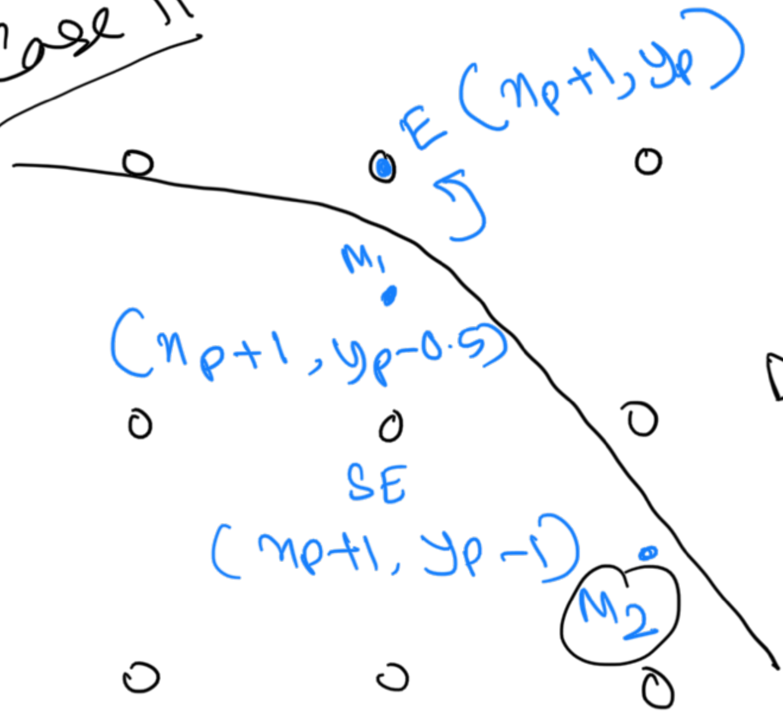
If we choose SE

NEXT MIDPOINT

$$D_{new} = (x_p+1+1 \quad , y_p-0.5-1)$$

$$D_{new} = (x_p+2, \; y_p-1.5)$$

Case II



If we choose E

Next Midpoint

$$D_{new} = (x_p+1+1, \; y_p-0.5)$$

$$= (x_p+2, y_p-0.5)$$

$$D = f(x_p+1, \; y_p-0.5) \qquad x^2+y^2-r^2$$

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

$$= \boxed{x_p^2+2x_p+1+y_p^2-y_p+0.25-r^2}$$

If Pixel SE, // $d>0$

D = f(

$D_{new} = f(x_p + 2, y_p - 1.5)$

$= (x_p+2)^2 + (y_p - 1.5)^2 - r^2$

$= x_p^2 + 4x_p + 4 + y_p^2 - 3y_p + 2.25 - r^2$

$D_{new} - D = 2x_p + 3 - 2y_p + 2$

$\boxed{D_{new} = D + 2x_p - 2y_p + 5}$ // SE, $d > 0$ ←

If $\boxed{E}$ // $d < 0$

$D_{new} = f(x_p + 2, y_p - 0.5)$

$D_{new} = (x_p+2)^2 + (y_p - 0.5)^2 - r^2$

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

$D_{new} - D = \cancel{x_p^2} + 4x_p + 4 + \cancel{y_p^2} - \cancel{y_p} + \cancel{0.25} - \cancel{r^2}$
$- \cancel{x_p^2} - 2x_p - 1 - \cancel{y_p^2} - \cancel{y_p} - \cancel{0.25} + \cancel{r^2}$

$\boxed{D_{new} = D + 2x_p + 3}$ ←

Starting
$x_p = 0$
$y_p = r$

$x^2 + y^2 - r^2$

$D_{in} = f(x_p + 1, y_p - 1/2)$

$= f(1, r - 0.5)$

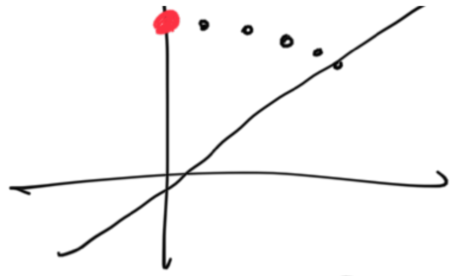
$= 1^2 + (r - 0.5)^2 - r^2$

$= 1 + \cancel{r^2} - r + 0.25 - \cancel{r^2}$

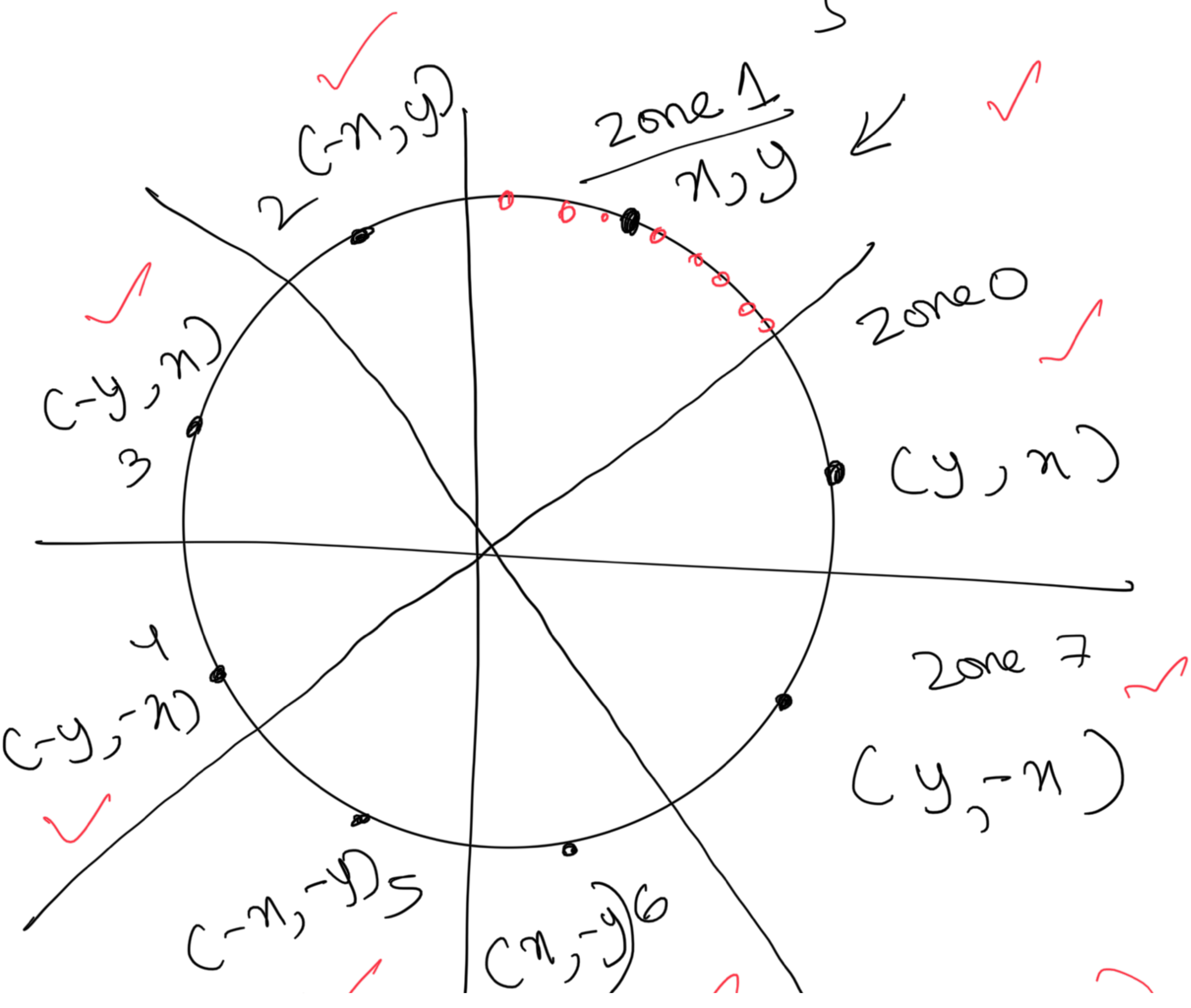
$D = 1.25 - r$

Round off $\boxed{D = 1 - r}$

Func Midpoint Circle (int r, int value)
int x, y, d;



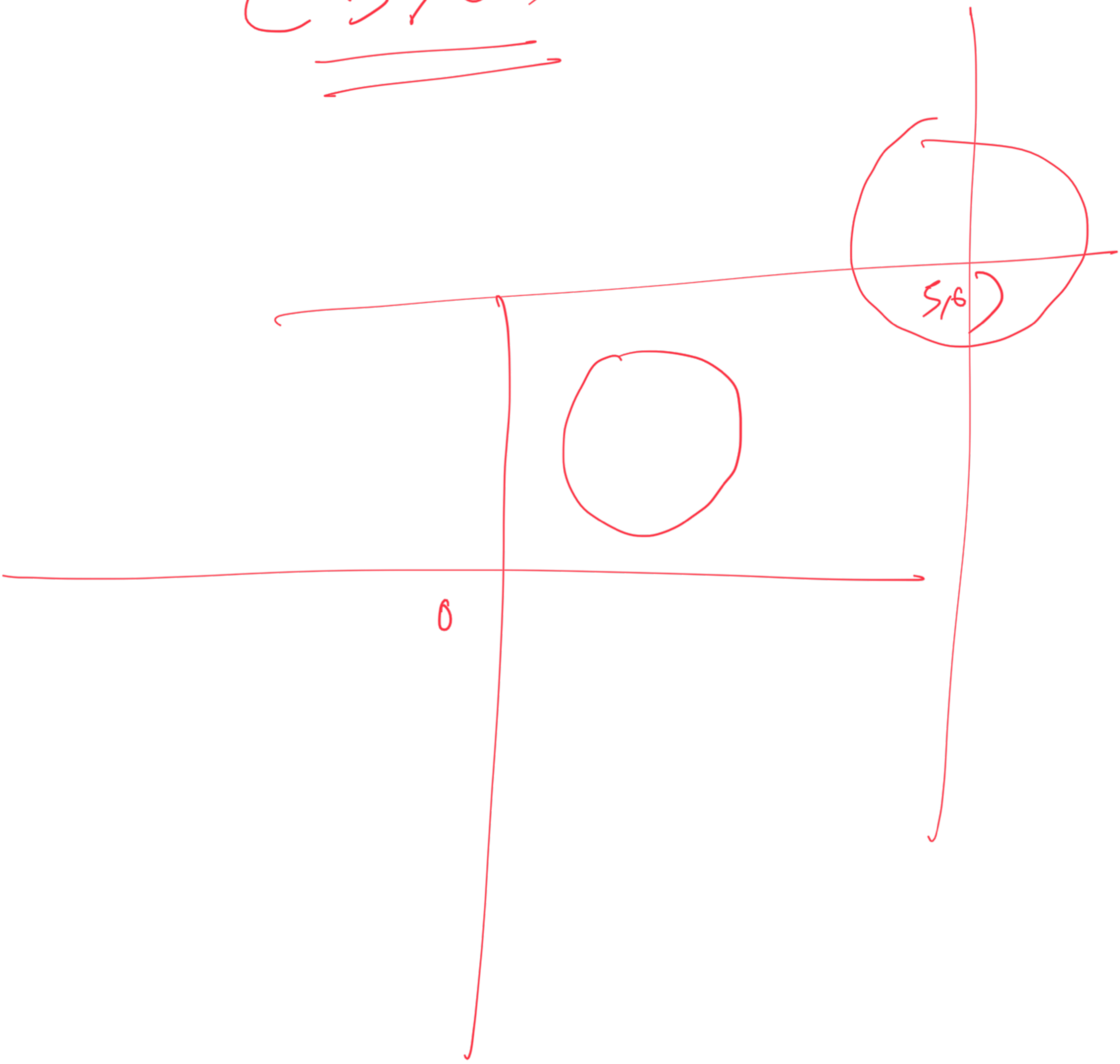
```
d = 1 - r
x = 0
y = r
Circlepoints (x, y, value)
While x < y {
    if (d < 0) {     // E
        d = d + 2x + 3
        x = x + 1    }
    else {     // SE

        d = d + 2x - 2y + 5
        x = x + 1
        y = y - 1    }
    Circle (x, y, value) }
}
```



$(0,5)$

Centre $(0,0)$

$(5,6)$



x, y	$x+5, y+6$