9-Simple DDA algorithm (Digital Differential Analysis)

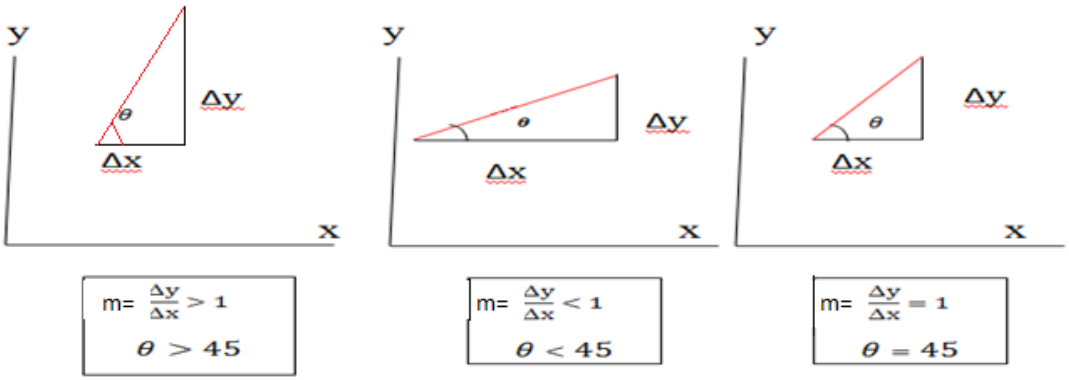
It is a simple scan conversion (The process of representing continuous graphics objects as a collection of discrete pixel called Scan conversion) based on the calculation of

$$\Delta y = m \cdot \Delta x$$

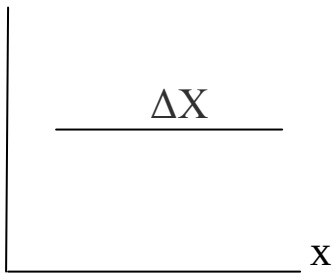
Or

$$\Delta x = \frac{\Delta y}{m}$$

Depending on the line slope. Where $m = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$

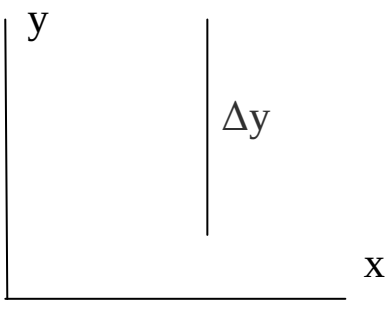


y



Δy=0

$m = \frac{\Delta y}{\Delta x} = \mathbf{0}$



Δx=0

$m = \frac{\Delta y}{\Delta x} = \infty$

Procedure-

Given-

- Starting coordinates = (X_1, Y_1)
- Ending coordinates = (X_n, Y_n)

The points generation using DDA Algorithm involves the following steps-

Step-1:

Calculate ΔX, ΔY and M from the given input.

These parameters are calculated as-

- $\Delta X = X_n - X_1$
- $\Delta Y = Y_n - Y_1$
- $M = \Delta Y / \Delta X$

Step-2:

Find the number of steps or points in between the starting and ending coordinates (length).

if (absolute (ΔX) > absolute (ΔY)) → M< 1

Steps = absolute (ΔX);

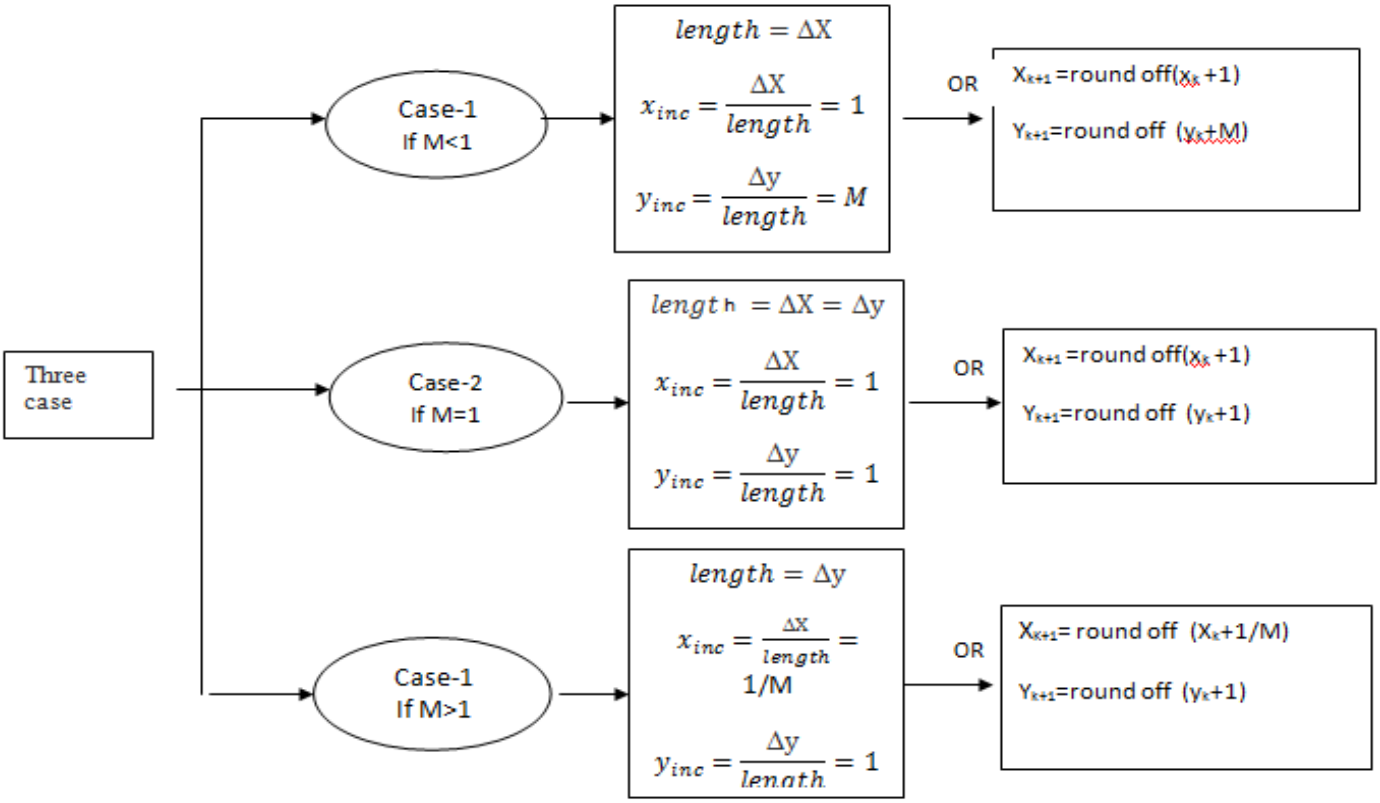
else

Steps = absolute (ΔY); → M>1

Step-03:

Suppose the current point is (X_k, Y_k) and the next point is (X_{k+1}, Y_{k+1}).

Find the next point by following the below three cases-



❖ This is to draw a line from the left endpoint to the right endpoint. If this processing is reversed from right to left we have:

dx=-1 and $\boldsymbol{y_{k+1} = y_k - m}$

or

dy =-1 and $\boldsymbol{x_{k+1} = x_k - 1/m}$

Step-04:

Keep repeating Step-03 until the end point is reached or the number of generated new points (including the starting and ending points) equals to the steps count.

(At first k=0 and then x or y is increased by 1 from first point to the final point.)

Algorithms of DDA

$dx=x_2-x_1$

$dy=y_2-y_1$

If (abs (dx)>abs(dy))

length=abs(dx)

els

length=abs(dy)

x_{inc}= (dx)/ (length);

y_{inc}= (dy)/ (length);

For(k=0;k<=length ;k++)

{

$x=x+x_{inc;}$

$y=y+y_{inc}$;

Putpixel (x,y);

}

PRACTICE PROBLEMS BASED ON DDA ALGORITHM-

Problem-01:

Calculate the points between the starting point (5, 4) and ending point (12, 7).

Solution-

(x_1,y_1) (x_2,y_2)

(5,4)(12,7)

ΔX=12-5=7

Δy=7-4=3

$m = \frac{\Delta y}{\Delta X} = \frac{3}{7}$ $m < 1$

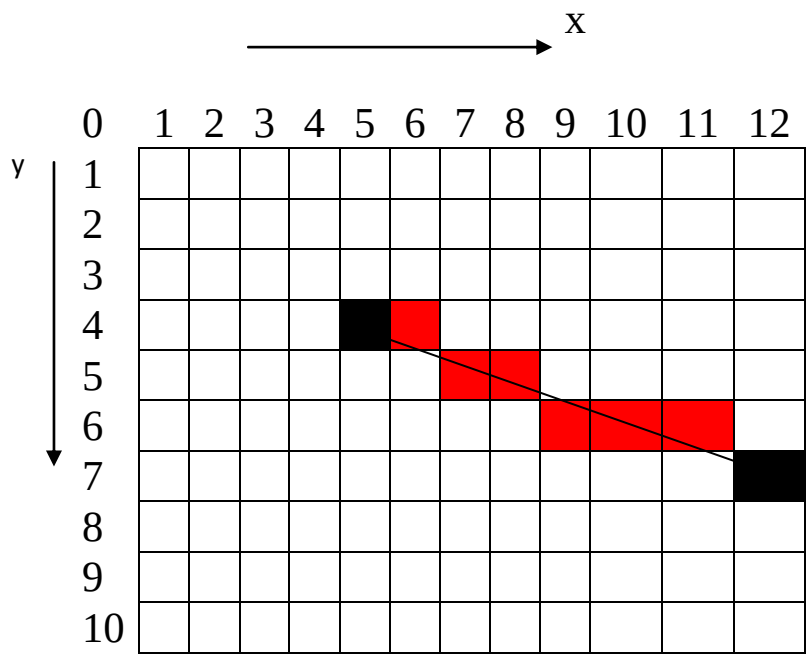
$|x_2 - x_1| > |y_2 - y_1|$

As m< 1, so case-1 is satisfied. ΔX = $length = 7$

$x_{inc} = \frac{\Delta X}{length} = \frac{7}{7} = 1$

$y_{inc} = \frac{\Delta y}{length} = \frac{3}{7} = 0.4$

k	x	y	X plotted	Y plotted
0	5	4	5	4
1	6	4.4	6	4
2	7	4.8	7	5
3	8	5.2	8	5
4	9	5.6	9	6
5	10	6	10	6
6	11	6.4	11	6
7	12	6.8	12	7



Problem-02:

Calculate the points between the starting point (5, 7) and ending point (10, 15).

Solution-

(5,7)(10,15)

ΔX=10-5=5

Δy=15-7=8

$m = \frac{\Delta y}{\Delta X} = \frac{8}{5}$ $m > 1$

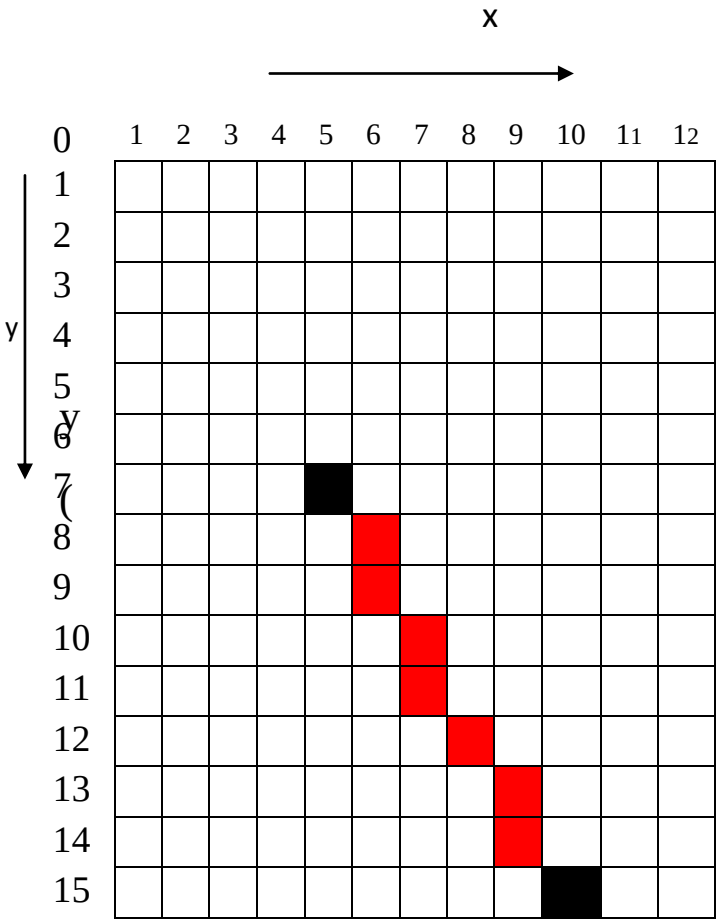
$|x_2 - x_1| < |y_2 - y_1|$

As m> 1, so case-3 is satisfied. $\Delta y = length = 8$

$x_{inc} = \frac{\Delta X}{length} = \frac{5}{8} = 0.6$

$y_{inc} = \frac{\Delta y}{length} = \frac{8}{8} = 1$

k	x	y	X plotted	Y plotted
0	5	7	5	7
1	5.6	8	6	8
2	6.2	9	6	9
3	6.8	10	7	10
4	7.4	11	7	11
5	8	12	8	12
6	8.6	13	9	13
7	9.2	14	9	14
8	9.8	15	10	15



Problem-03:

Calculate the points between the starting point (3, 5) and ending point (8, 10).

Solution-

(x_1,y_1) (x_2,y_2)

(3,5)(8,10)

$\Delta X=8-3=5$

$\Delta y=10-5=5$

$m = \frac{\Delta y}{\Delta X} = \frac{5}{5} = 1$ $\quad m = 1$

$|x_2 - x_1| = |y_2 - y_1|$

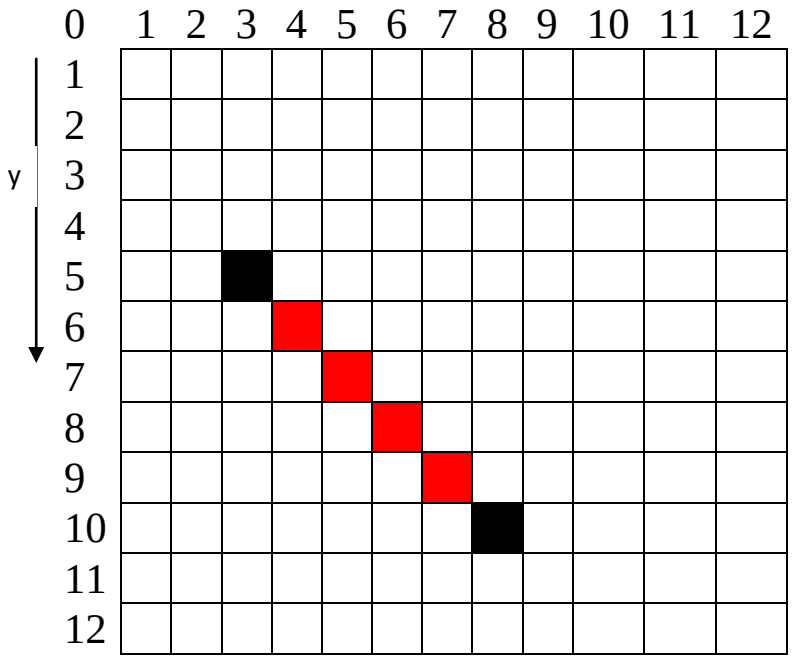
As M = 1, so case − 2 is satisfied $\Delta X = \Delta y = length = 5$

$x_{inc} = \frac{\Delta X}{length} = \frac{5}{5} = 1$

$y_{inc} = \frac{\Delta y}{length} = \frac{5}{5} = 1$

```
dx=x2-x1
dy=y2-y1
If (abs (dx)=abs(dy))
length=abs(dx)=abs(dy)
xinc=dx/length
yinc=dy/length
For(k=0;k<=length ;k++)
{
x=x1+xinc;
y=y1+yinc;
Putpixel (x,y);
}
```

k	x	y
0	3	5
1	4	6
2	5	7
3	6	8
4	7	9
5	8	10



Problem-04:

Calculate the points between the starting point (8, 10) and ending point (3, 5).

Solution-

(x_1,y_1) (x_2,y_2)

(8,10)(3,5)

$\Delta X=3-8=-5$

$\Delta y=5-10=-5$

$m = \frac{\Delta y}{\Delta X} = \frac{-5}{-5} = 1$ $\quad m = 1$

$|x_2 - x_1| = |y_2 - y_1|$

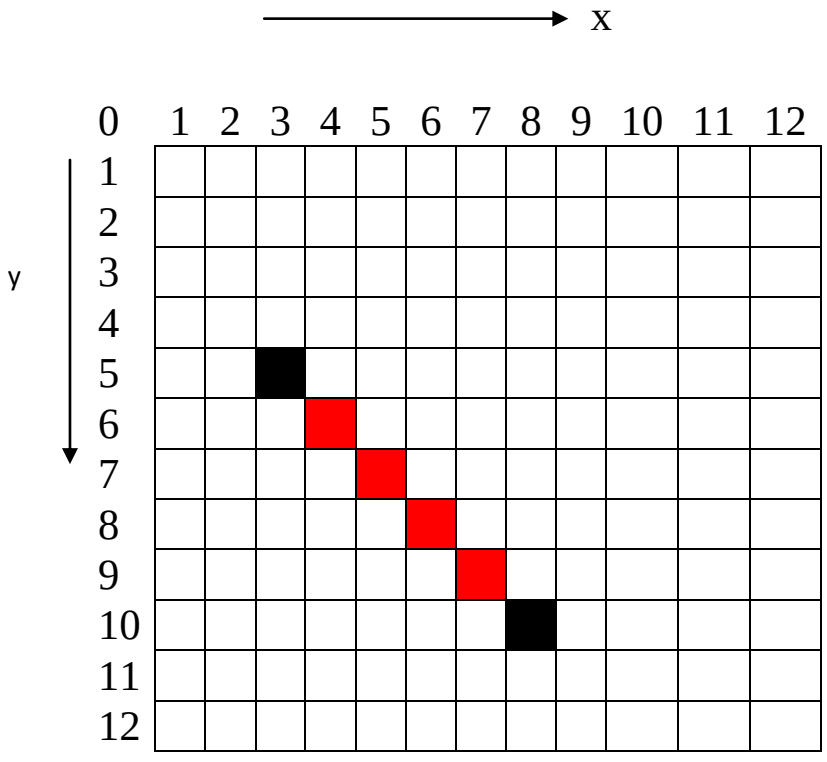
$\Delta X = \Delta y = length = 5$

$x_{inc} = \frac{\Delta X}{length} = \frac{-5}{5} = -1$

$y_{inc} = \frac{\Delta y}{length} = \frac{-5}{5} = -1$

```
dx=x2-x1
dx=y2-y1
If (abs (dx)=abs(dy))
length=abs(dx)=abs(dy)
xinc=dx/length
yinc=dy/length
For(k=0;k<=length ;k++)
{
x=x1-xinc;
y=y1-yinc;
Putpixel (x,y);
}
```

k	x	y
0	8	10
1	7	9
2	6	8
3	5	7
4	4	6
5	3	5



Problem-05:

Calculate the points between the starting point (2, 2) and ending point (9, 2).

Solution-

(x_1,y_1) (x_2,y_2)

(2,2)(9,2)

ΔX=9-2=7

Δy=2-2=0

$$m = \frac{\Delta y}{\Delta X} = \frac{0}{7} = 0$$

$$|x_2 - x_1| > |y_2 - y_1|$$

$$length = 7$$

$$x_{inc} = \frac{\Delta X}{length} = \frac{7}{7} = 1$$

$$y_{inc} = \frac{\Delta y}{length} = \frac{0}{7} = 0$$

```
dx=x2-x1
dy=y2-y1
If (dy=0)
Length=abs(dx)
xinc=dx/length
For(k=0;k<=length ;k++)
{
x=x1+xinc;
y=y1+yinc;
Putpixel (x,y);
}
```

k	x	y
0	2	2
1	3	2
2	4	2
3	5	2
4	6	2
5	7	2
6	8	2
7	9	2