Line Drawing Algorithm

- The Line drawing algorithm is a graphical algorithm which is used to represent the line segment on discrete graphical media, i.e., printer and pixel-based media.
- A line contains two points. The point is an important element of a line.

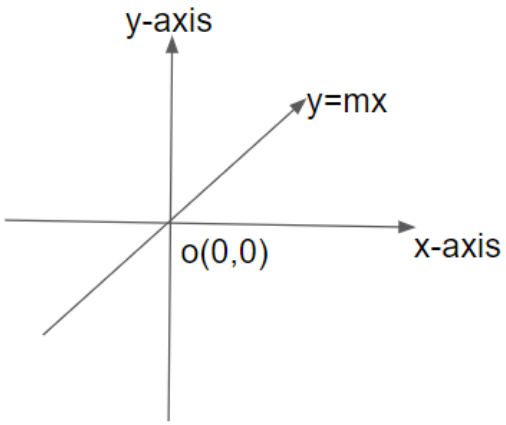
properties of a Line Drawing Algorithm

- **An algorithm should be precise**: Each step of the algorithm must be adequately defined.
- **Finiteness**: An algorithm must contain finiteness. It means the algorithm stops after the execution of all steps.
- **Easy to understand**: An algorithm must help learners to understand the solution in a more natural way.
- **Correctness**: An algorithm must be in the correct manner.
- **Effectiveness**: The steps of an algorithm must be valid and efficient.
- **Uniqueness**: All steps of an algorithm should be clearly and uniquely defined, and the result should be based on the given input.
- **Input**: A good algorithm must accept at least one or more input.
- **Output**: An algorithm must generate at least one output

The formula for a slope line interception is:

$Y = mx + b$

In this formula, m is the slope line and b is the line's intercept of y. Two endpoints for the line segment are supplied in coordinates (x1, y1) and (x2, y2).



Types of Line Drawing Algorithm

- DDA (Digital Differential Analyzer) Line Drawing Algorithm
- Bresenham's Line Drawing Algorithm

DDA (Digital Differential Analyzer)

Digital Differential Analyzer algorithm is also known as an incremental method of scan conversion.

Algorithm of Digital Differential Analyzer (DDA) Line Drawing

Step 1: Start.

Step 2: We consider Starting point as (x1, y1), and ending point (x2, y2).

Step 3: Now, we have to calculate ▲x and ▲y.

▲x = x2-x1

▲y = y2-y1

$$m = \blacktriangle y / \blacktriangle x$$

Step 4: Now, we calculate three cases.

Case 1: If m < 1

$$x_{k+1} = x_k + 1$$
$$y_{k+1} = y_k + m$$

Case 2: If m>1

$$y_{k+1} = y_k + 1$$
$$x_{k+1} = x_k + 1/m$$

Case 3: If m=1

$$x_{k+1} = x_k + 1$$
$$y_{k+1} = y_k + 1$$

Step 5: We will repeat step 4 until we find the ending point of the line.

Step 6: Stop

Example: A line has a starting point (1,7) and ending point (11,17). Apply the Digital Differential Analyzer algorithm to plot a line.

Step 1: Consider Starting Point = **(x_1, y_1)** = **(1,7)**
Ending Point = **(x_2, y_2)** = **(11,17)**

Step 2: calculate m

▲x = x2 – x1 = 11-1 = 10
▲y = y2 – y1 = 17-7 = 10

$$m = \blacktriangle y / \blacktriangle x = 10/10 = 1$$

Step 3: We get m = 1, Third case is satisfied

x_k	y_k	x_{k+1}	y_{k+1}	(x_{k+1}, y_{k+1})
1	7	2	8	(2, 8)
		3	9	(3, 9)
		4	10	(4, 10)
		5	11	(5, 11)
		6	12	(6, 12)
		7	13	(7, 13)
		8	14	(8, 14)
		9	15	(9, 15)
		10	16	(10, 16)
		11	17	(11, 17)

Step 4: We will repeat step 3 until we get the endpoints of the line.
Step 5: Stop.
The coordinates of drawn line are

P1 = (2, 8)

P2 = (3, 9)

P3 = (4, 10)

P4 = (5, 11)

P5 = (6, 12)

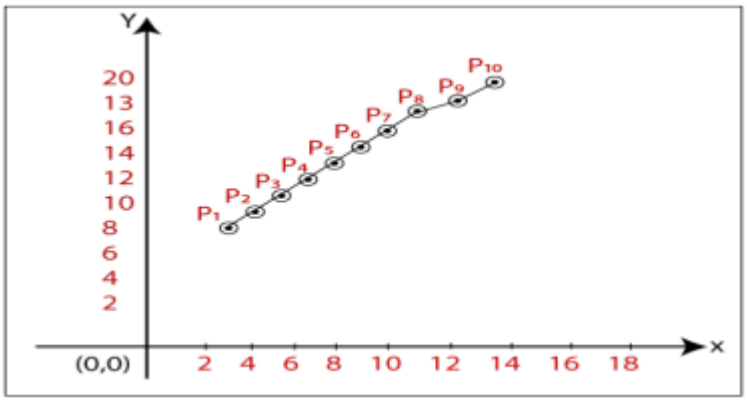
P6 = (7, 13)

P7 = (8, 14)

P8 = (9, 15)

P9 = (10, 16)

P10 = (11, 17



Bresenham's Line Drawing Algorithm

- This algorithm was introduced by **"Jack Elton Bresenham"** in **1962.**
- This algorithm helps us to perform scan conversion of a line.
- It is a powerful, useful, and accurate method.
- We use incremental integer calculations to draw a line. The integer calculations include addition, subtraction, and multiplication.

Algorithm of Bresenham's Line Drawing Algorithm

Step 1: Start.

Step 2: Now, we consider Starting point as (x1, y1) and ending point (x2, y2).

Step 3: Now, we have to calculate ▲x and ▲y.

▲x = x2-x1

▲y = y2-y1

m = ▲y/▲x

Step 4: Now, we will calculate the decision parameter pk with following formula.

$$pk = 2\blacktriangle y - \blacktriangle x$$

Step 5: The initial coordinates of the line are (xk, yk), and the next coordinates are (xk+1, yk+1).

Now, we are going to calculate two cases for decision parameter pk

Case 1: If pk < 0 Then

pk+1 =pk +2▲y

xk+1 = xk +1

yk+1 = yk

Case 2: If pk >= 0 Then

pk+1 =pk +2▲y-2▲x

xk+1 =xk +1

yk+1 =yk +1

Step 6: We will repeat step 5 until we found the ending point of the line and the total number of iterations = ▲x-1.

Step 7: Stop

Example: A line has a starting point (9,18) and ending point (14,22). Apply the Bresenham's Line Drawing algorithm to plot a line.

Step 1:Consider, Starting Point = (x1, y1) = (9,18)

Ending Point = (x2, y2) = (14,22)

Step 2: First, we calculate ▲x, ▲y.

▲x = x2 – x1 = 14-9 = 5

▲y = y2 – y1 = 22-18 = 4

Step 3: Calculate the decision parameter

(pk) pk = 2▲y-▲x = 2 x 4 – 5 = 3

The value of pk = 3

Step 3: Now, we will check both the cases.

If pk >= 0 Then Case 2 is satisfied.

Thus pk+1 = pk +2▲y-2▲x =3+ (2 x 4) – (2 x 5) = 1

xk+1 =xk +1 = 9 + 1 = 10

yk+1 =yk +1 = 18 +1 = 19

Step 4: Now move to next step. We will calculate the coordinates until we reach the end point of the line.

Step 5:Stop

p_k	p_{k+1}	x_{k+1}	y_{k+1}
		9	18
3	1	10	19
1	-1	11	20
-1	7	12	20
7	5	13	21
5	3	14	22

The Coordinates of drawn lines are

P1 = (9, 18)

P2 = (10, 19)

P3 = (11, 20)

P4 = (12, 20)

P5 = (13, 21)

P6 = (14, 22)