Computer Graphics

Line Drawing Algorithms

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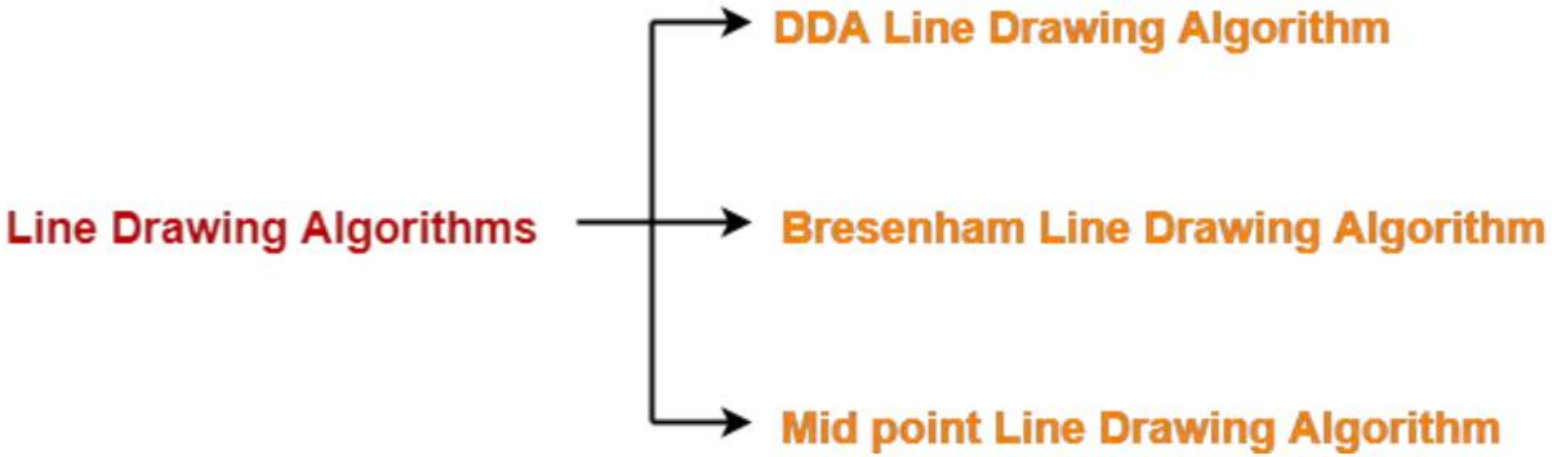
Line Drawing Algorithms

- In computer graphics, popular algorithms used to generate lines are-

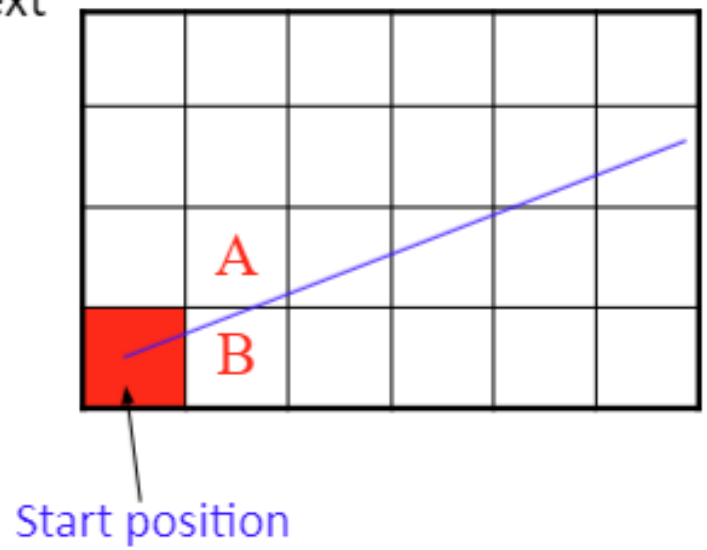


Bresenham's Line Algorithm

- **DDA algorithm**, DDA has the following problems:
  - Accumulation of round-off errors can make the pixelated line drift away from the intended.
  - The rounding operations and floating point arithmetic involved are time consuming.
- **The Bresenham line algorithm** has the following advantages:
  - A fast incremental algorithm.
  - Uses only integer calculations.

Bresenham's Line Algorithm

- Basis of the algorithm:
- From start position decide A or B next



Bresenham's Line Algorithm

Procedure

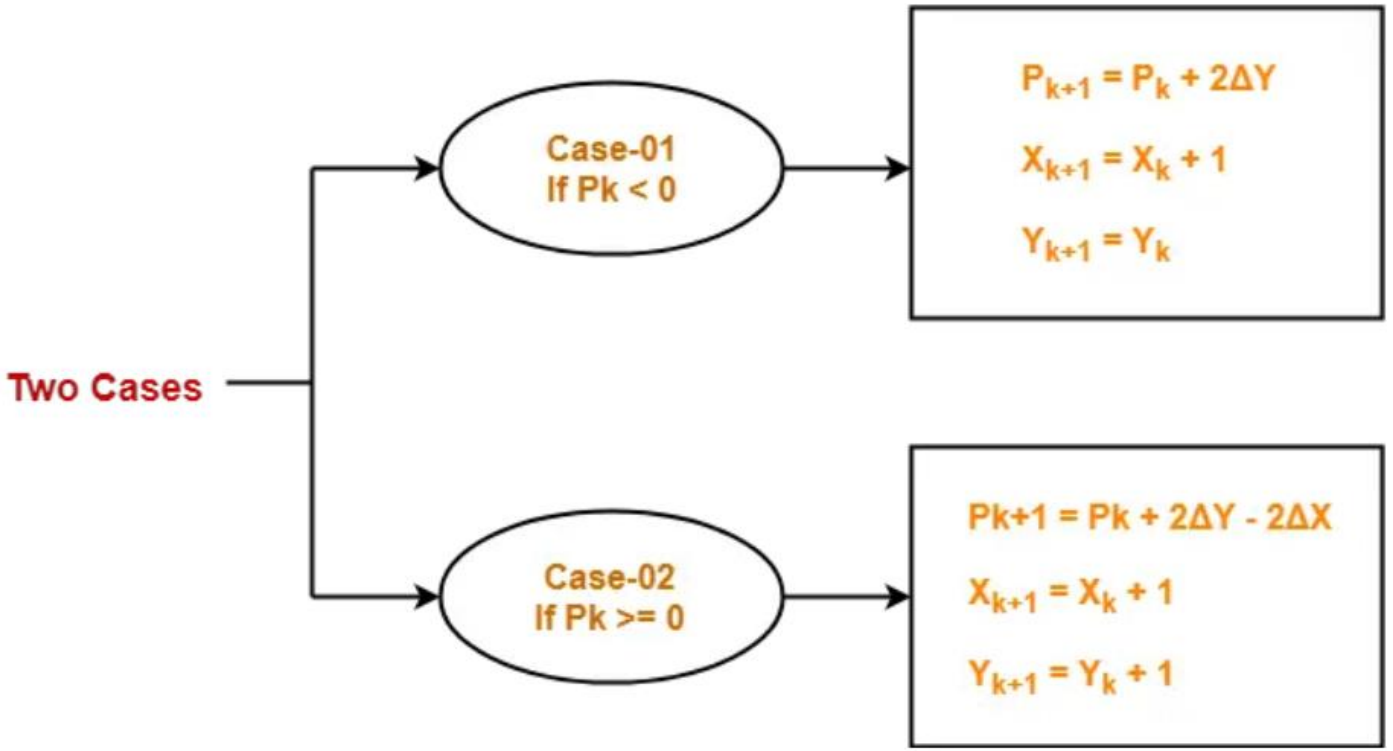
- Given-
  - Starting coordinates = (X_0, Y_0)
  - Ending coordinates = (X_n, Y_n)
- The points generation using Bresenham Line Drawing Algorithm involves the following steps-
- **Step-01:**
  - Calculate ΔX and ΔY from the given input.
  - These parameters are calculated as-

    $\Delta X = X_n - X_0$

    $\Delta Y = Y_n - Y_0$
- **Step-02:**
  - Calculate the decision parameter P_k.
  - $Pk = 2\Delta Y - \Delta X$

Bresenham's Line Algorithm

- **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 depending on the value of decision parameter P_k.



- **Step-04:**
  - Keep repeating Step-03 until the end point is reached or number of iterations equals to (ΔX-1) times.

Bresenham's Line Algorithm – Practice Problems

Problem-01: Calculate the points between the starting coordinates (9, 18) and ending coordinates (14, 22).

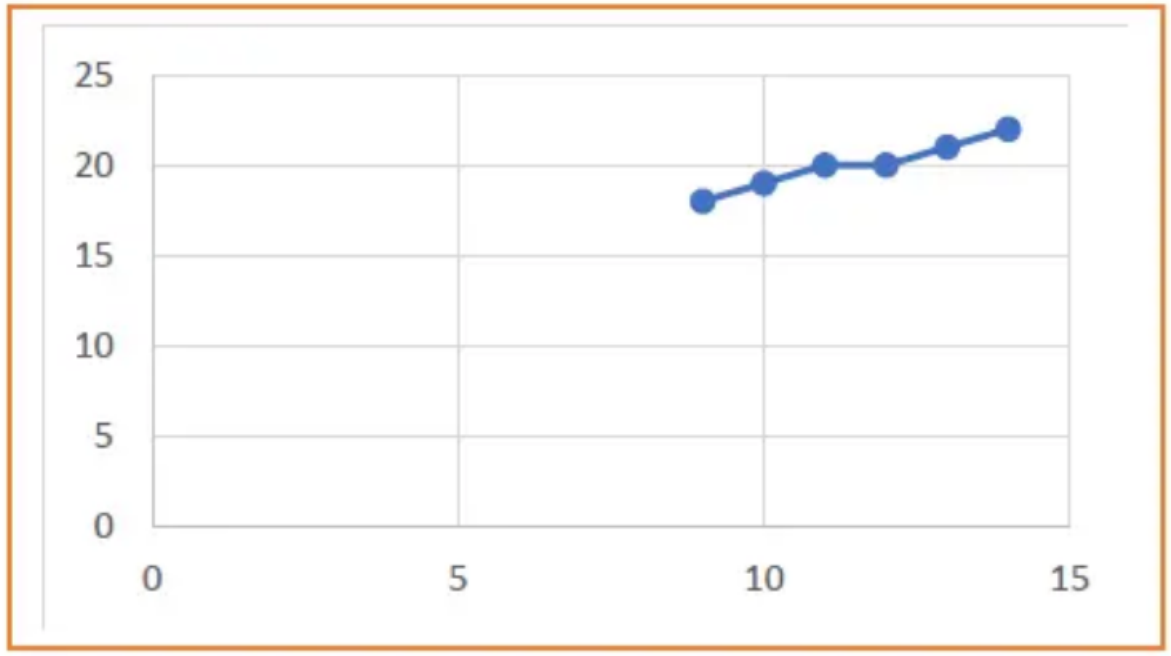
Solution:

- Step-01: Calculate ΔX and ΔY from the given input.
  - $\Delta X = X_n - X_0 = 14 - 9 = 5$
  - $\Delta Y = Y_n - Y_0 = 22 - 18 = 4$
- Step-02: Calculate the decision parameter.
  - $P_k = 2\Delta Y - \Delta X = 2 \times 4 - 5 = 3$
  - So, decision parameter $P_k = 3$
- Step-03: As $P_k >= 0$, so case-02 is satisfied.
  - $P_{k+1} = P_k + 2\Delta Y - 2\Delta X = 3 + (2 \times 4) - (2 \times 5) = 1$
  - $X_{k+1} = X_{k+1} = 9 + 1 = 10$
  - $Y_{k+1} = Y_{k+1} = 18 + 1 = 19$
- Step-03 is executed until the end point is reached or number of iterations equals to 4 times.
- (Number of iterations = $\Delta X - 1 = 5 - 1 = 4$)

Bresenham's Line Algorithm – Practice Problems

- Step-03 is executed until the end point is reached or number of iterations equals to 4 times.
  - (Number of iterations = ΔX – 1 = 5 – 1 = 4)

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



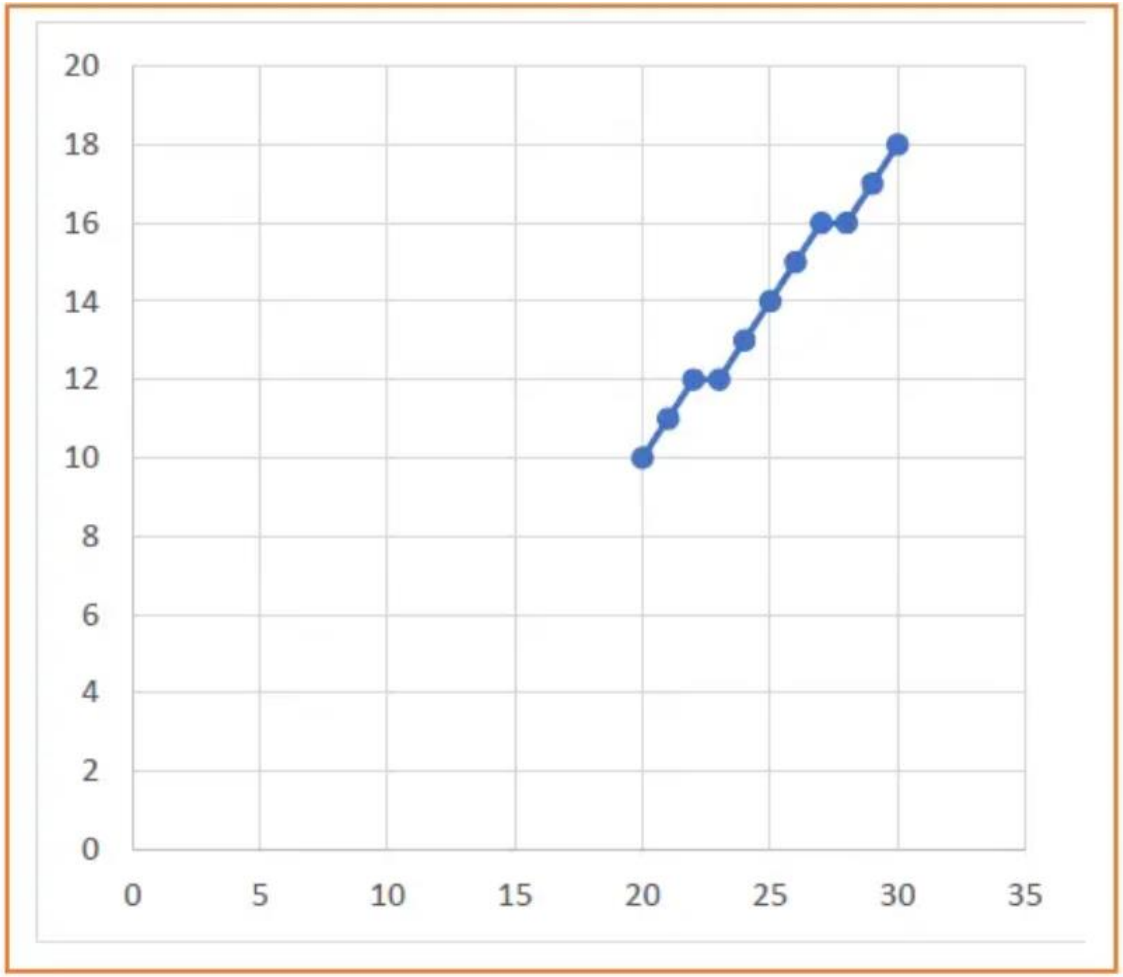
Bresenham's Line Algorithm – Practice Problems

Problem-02: Calculate the points between the (20, 10) and (30, 18).

Bresenham's Line Algorithm – Practice Problems

Problem-02: Calculate the points between the (20, 10) and (30, 18).

P_k	P_{k+1}	X_{k+1}	Y_{k+1}
		20	10
6	2	21	11
2	-2	22	12
-2	14	23	12
14	10	24	13
10	6	25	14
6	2	26	15
2	-2	27	16
-2	14	28	16
14	10	29	17
10	6	30	18



Bresenham's Line Algorithm – Self Study

Task: Find the equations for different slopes and practice at least one problem from each types.

Thank You ☺