实验2:直线绘制算法
Line Drawing Algorithm

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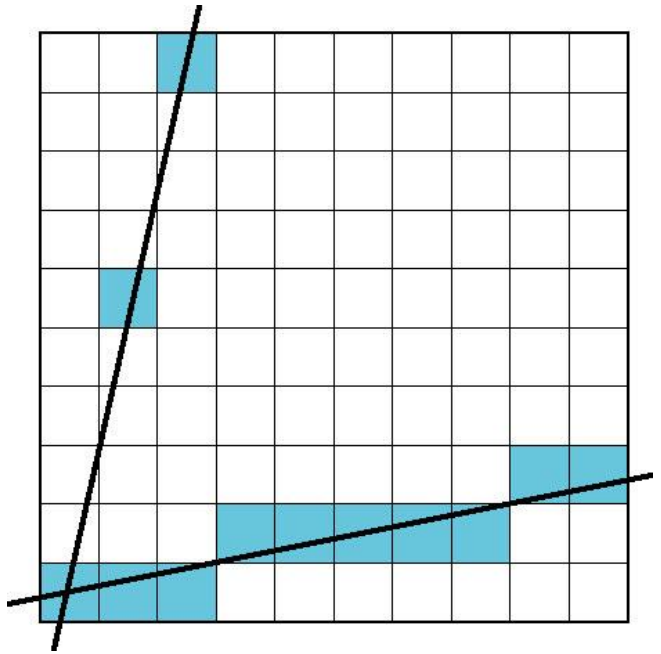
Digital Differential Analyzer (DDA)

- Input
  - Starting coordinates = (X_1, Y_1)
  - Ending coordinates = (X_2, Y_2)
- Objective
  - Raster $Y=mx+c$ to pixels

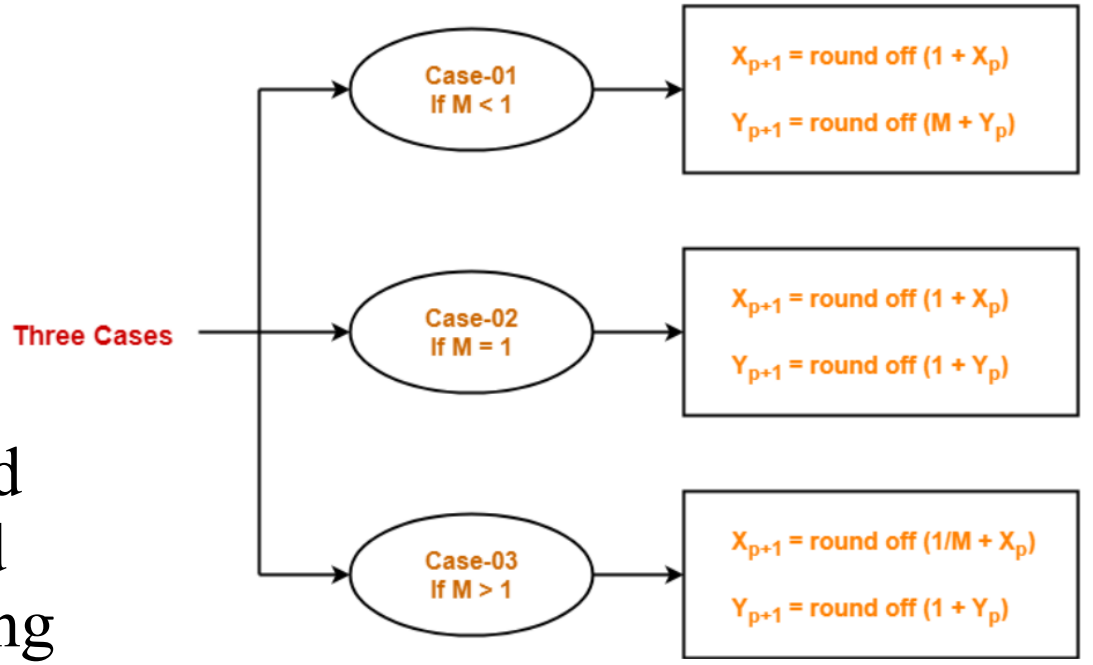


Digital Differential Analyzer (DDA)

- Step 1： Calculate ΔX, ΔY from the given input.
  - $\Delta X = X_2 - X_1$
  - $\Delta \mathrm{Y} = Y_2 - Y_1$
- Step 2： Find the number of steps or points in between the starting and ending coordinates.
  - if ($abs\ (\Delta X) > abs\ (\Delta Y)$)
    - $Steps = abs\ (\Delta X)$;
  - else
    - $Steps = abs\ (\Delta Y)$;

Digital Differential Analyzer (DDA)

- Step 3： Suppose the current point is (X_p, Y_p) and the next point is (X_{p+1}, Y_{p+1}). Find the next point by following rules.
  - $x_{inc} = abs\ (\Delta X)/Steps$;
  - $y_{inc} = abs\ (\Delta Y)/Steps$;
  - $X_{p+1} = X_p + x_{inc}$;
  - $Y_{p+1} = Y_p + y_{inc}$;



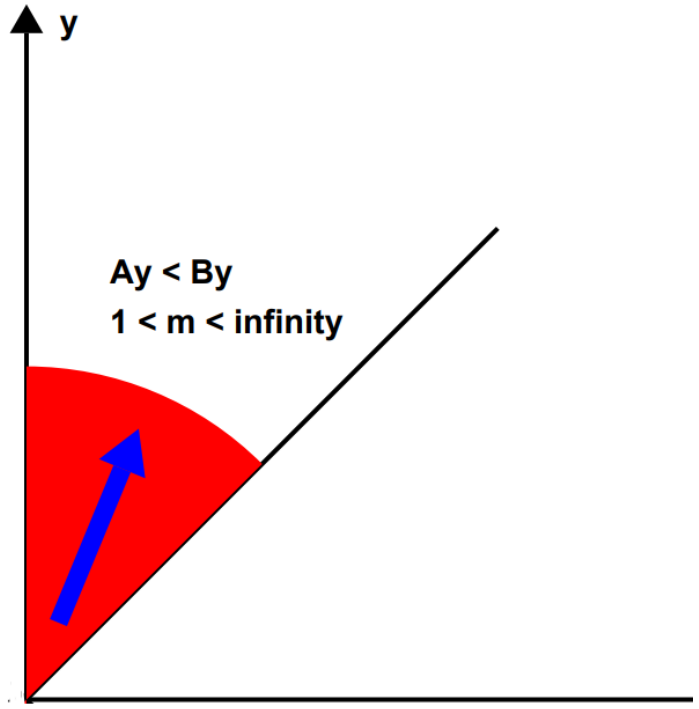
- Step 4： Keep repeating Step 3 until the end point is reached or the number of generated new points (including the starting and ending points) equals to the steps count.

Advantages and Disadvantages of DDA Algorithm

- Advantages :
  - Simplest line drawing algorithm
  - DDA draws the line faster than drawing the line by directly using the line equation.
- Disadvantages :
  - The native floating-point implementation requires one addition and one rounding operation per interpolated value, which is time consuming.
  - As the points that we get from the DDA algorithm are not accurate, the lines generated by this algorithm are not smooth, i.e. some discontinuation and zigzag nature can be commonly seen in the lines drawn through this algorithm.

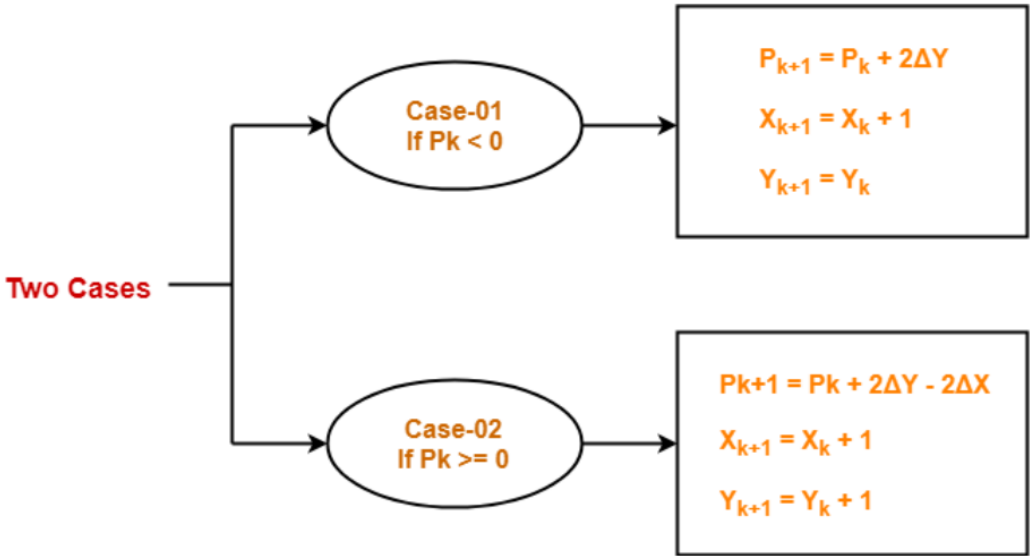
Bresenham Line Drawing Algorithm

- Step 1: Calculate ΔX and ΔY from the given input.
  - $\Delta X = X_2 - X_1$
  - $\Delta Y = Y_2 - Y_1$
- Step 2: Check if swapping happens.
  - if ($abs\ (\Delta Y) > abs\ (\Delta X)$)
    - *Swap*(*X*, *Y*);
- Step 3: Calculate the decision parameter P_k.
  - $P_k = 2\Delta Y - \Delta X$



Bresenham Line Drawing Algorithm

- Step 4: Suppose the current point is (X_p, Y_p) and the next point is (X_{p+1}, Y_{p+1}). Find the next point depending on the value of decision parameter P_k.



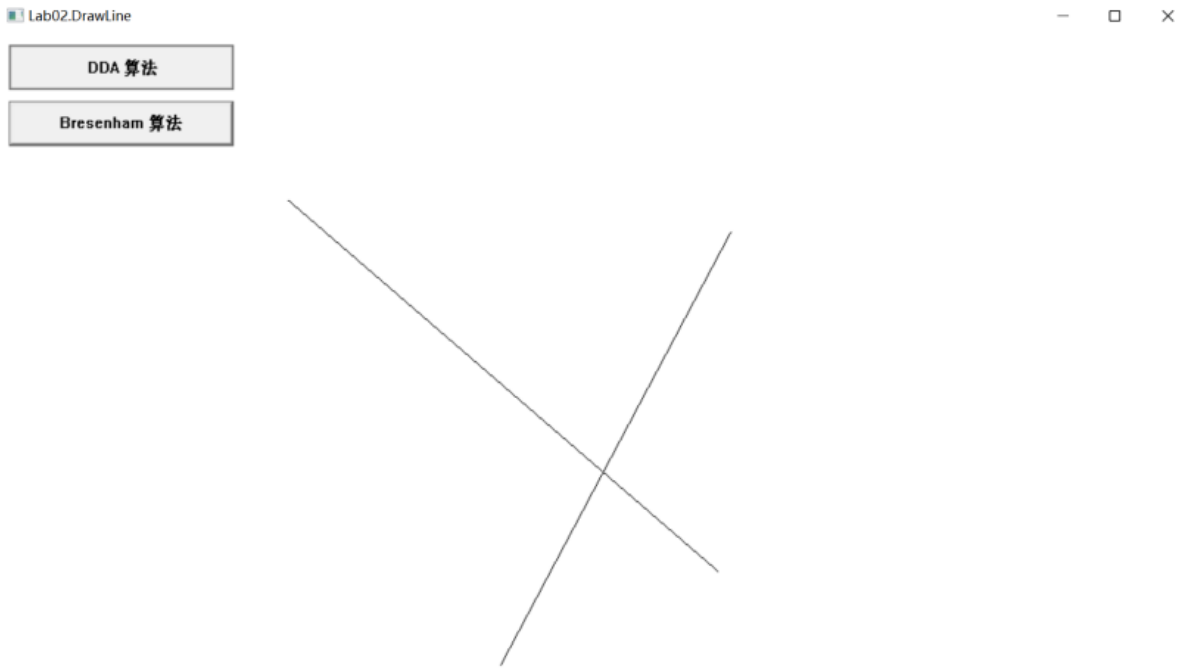
- Step 5: Keep repeating Step 3 until the end point is reached or number of iterations equals to $(\Delta X\text{-}1)$ times.

Advantages and Disadvantages of Bresenham Algorithm

- Advantages
  - It is fast and incremental because it does not involve floating point calculations like DDA Algorithm.
  - The points generated by this algorithm are more accurate than DDA Algorithm.
- Disadvantages
  - Though it improves the accuracy of generated points but still the resulted line is not smooth. It can not handle diminishing jaggies.
  - This algorithm is for the basic line drawing.

Assignment: Line Drawing Algorithm

- 实验编号：2
- 实验名称：直线绘制算法
- 实验内容
  - 实现DDA直线算法
  - 实现Bresenham直线算法



Extra Credit

- Could you list the differences between DDA algorithm and Bresenham algorithm?
  - Efficiency
  - Calculations involved
  - Arithmetic computation values
  - Precision
- Could you tell how faster is Bresenham algorithm compared with DDA algorithm?

Reference

- https://en.wikipedia.org/wiki/Line_drawing_algorithm
- https://en.wikipedia.org/wiki/Bresenham%27s_line_algorithm
- https://en.wikipedia.org/wiki/Digital_differential_analyzer_(graphics_algorithm)