Cohen-Sutherland Line Clipping

In this problem, you are given a clipping window (defining the “viewport”) and an example line, and asked to perform the steps of the line clipping algorithm we just learned in class. Assume the origin is at the top left and \( y \) is increasing going down (like HTML canvas).

**Input:** viewport defined by the lines \( x_{\text{min}} = 2, \ x_{\text{max}} = 10, \ y_{\text{min}} = 3, \ y_{\text{max}} = 8. \)

line defined by the points \( p_1 = (1, 5) \) and \( p_2 = (11, 1). \)

**Output:** \( p'_1 \) and \( p'_2 \), the points defining the line that should actually be drawn.

1. Draw out the viewport and the example line, labeling \( p_1, p_2, x_{\text{min}}, x_{\text{max}}, y_{\text{min}}, \) and \( y_{\text{max}}. \)

2. Write out the binary 4-digit codes for \( p_1 \) and \( p_2. \)

\[
p_1 : 0001 \\
p_2 : 1010
\]

3. Write out what case each point falls under and show how the algorithm would update the points. What are the final \( p'_1 \) and \( p'_2 \)?

\[
p'_1 : \text{case 3d. New point is } y = 0.4(2-1)+5 = 4.6, \ x = 2.
\]

\[
p'_2 : \text{case 3e. New point is } x = (3-1)/(-0.4)+11 = 6, \ y = 3
\]

4. Label \( p'_1 \) and \( p'_2 \) on your picture and make sure they agree visually with your calculations.

5. How many “rounds” of clipping are required to make this example line within the viewport? 2
Pseudocode for Cohen-Sutherland:

cohen_sutherland(p1,p2):
    code1 = getCode(p1);
    code2 = getCode(p2);
    if (code1|code2 == 0000) then // case 1
        drawLine(p1,p2)
    else if (code1 & code2 != 0000) then // case 2
        // skip line
    else if (code1 & 1000) then // case 3a
        p1new.x ← (ymin-p1.y)/m+p1.x, p1new.y ← ymin,
        cohen_sutherland(p1new,p2)
    else if (code1 & 0100) then // case 3b
        p1new.x ← (ymax-p1.y)/m+p1.x, p1new.y ← ymax,
        cohen_sutherland(p1new,p2)
    else if (code1 & 0010) then // case 3c
        p1new.y ← m(xmax-p1.x) +p1.y, p1new.x ← xmax,
        cohen_sutherland(p1new,p2)
    else if (code1 & 0001) then // case 3d
        p1new.y ← m(xmin-p1.x)+p1.y, p1new.x ← xmin,
        cohen_sutherland(p1new,p2)
    else if (code2 & 1000) then // case 3e
        p2new.x ← (ymin-p2.y)/m+p2.x, p2new.y ← ymin,
        cohen_sutherland(p1,p2new)
    else if (code2 & 0100) then // case 3f
        p2new.x ← (ymax-p2.y)/m+p2.x, p2new.y ← ymax,
        cohen_sutherland(p1,p2new)
    else if (code2 & 0010) then // case 3g
        p2new.y ← m(xmax-p2.x) +p2.y, p2new.x ← xmax,
        cohen_sutherland(p1,p2new)
    else if (code2 & 0001) then // case 3h
        p2new.y ← m(xmin-p2.x)+p2.y, p2new.x ← xmin,
        cohen_sutherland(p1,p2new)

6. Why are there eight subparts to case 3? What does each one represent/do?
   Each compares one of the endpoints with one of the viewport boundaries. 2 points x 4 sides = 8 cases.

7. A four-bit sequence allows for sixteen possible values, yet we only have nine regions. Which bit sequences
   are not used, and why do they represent nonsensical situations?
The unused values are nonsensical because they imply that a point is simultaneously both above and below the viewport, etc.

8. Which case would be activated for each of the following pairs of codes?
   a. 1010 and 0101  3a
   b. 0000 and 1001  3e
   c. 0110 and 0101  2
   d. 0001 and 0001  2