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# Computer Graphics

# 2D Viewing and Clipping

Prepared by
Dr. Md. Manjur Ahmed
Faculty of Computer Systems and Software Engineering
manjur@ump.edu.my

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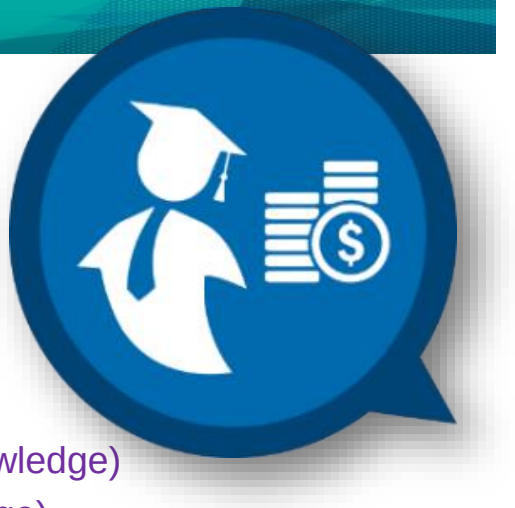
# Chapter Description



- Aims
  - Basic of Computer Graphics.

- Expected Outcomes
  - Understand the basic concept of computer graphics. (CO1: Knowledge)
  - Ability to use the computer graphics technology. (CO1: Knowledge)

- References
  - Computer Graphics by Zhigang Xiang, Schaum's Outlines.
  - Donald Hearn & M. Pauline Baker, Computer Graphics with OpenGL, 4th Edition, Boston : Addison Wesley, 2011.

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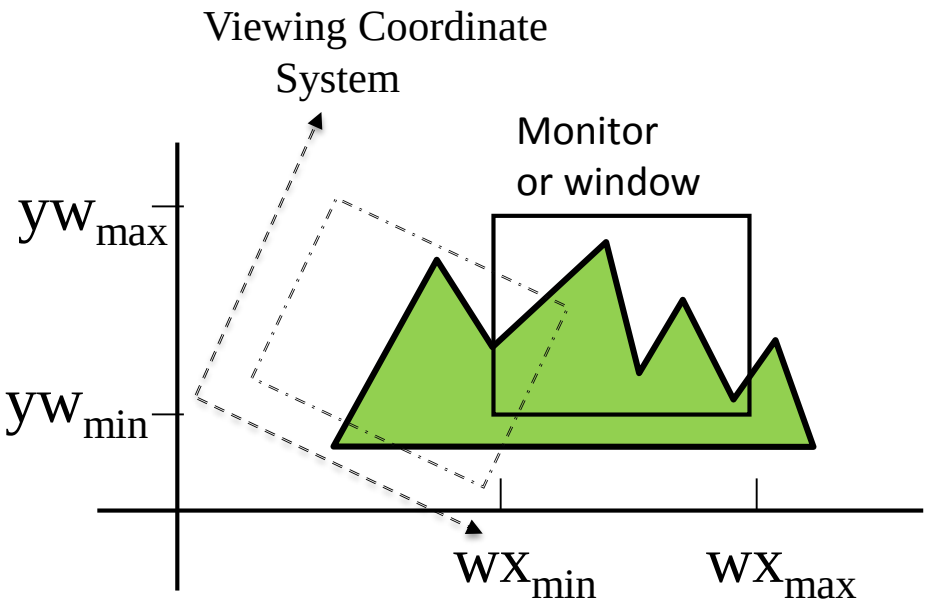
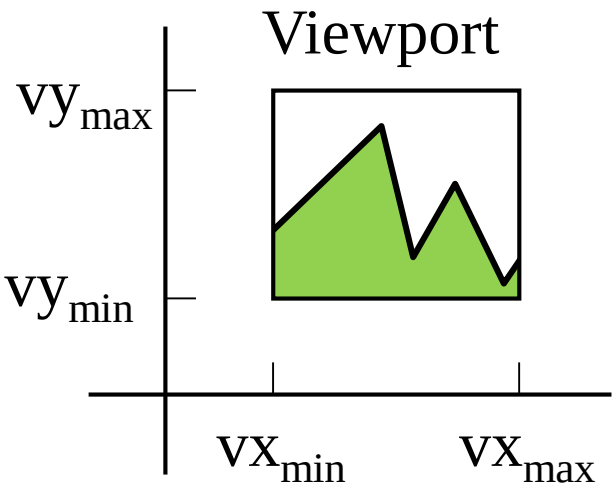
# Viewing transformation

- Master coordinate system, commonly referred to as the world coordinate system
  - ✓ Clipping window: What do we want to see?
  - ✓ Viewport: Where do we want to see it?




a) World Coordinate System




b) Device Coordinate System

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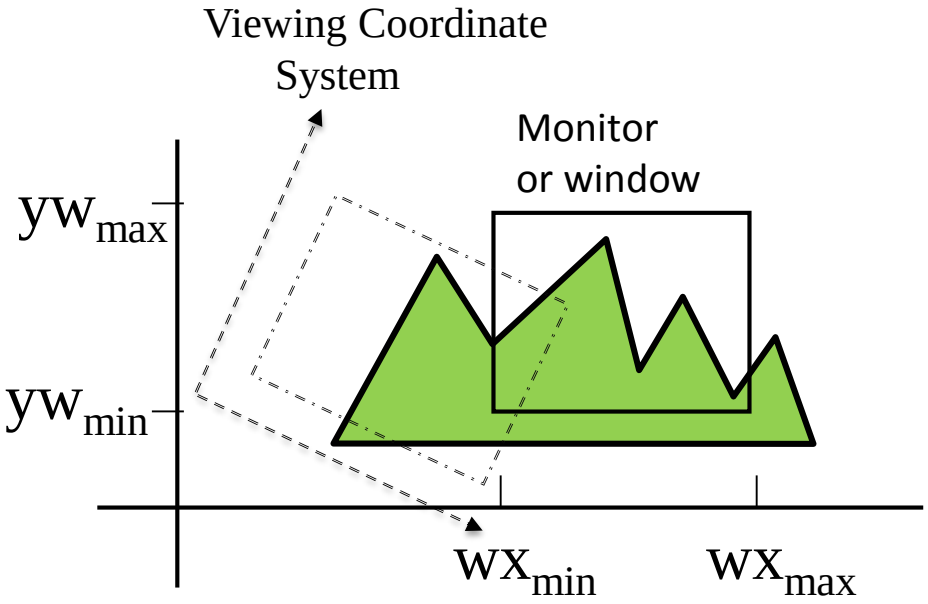
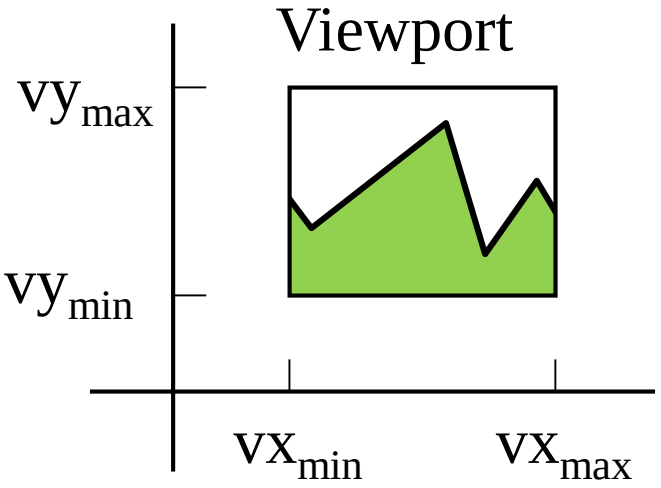
# Viewing transformation

- **Viewing Transformation**: coordinate-mapping operations between world and viewing coordinate system.
  - ✓ clipping window is mapped to the viewport




a) World Coordinate System




b) Device Coordinate System

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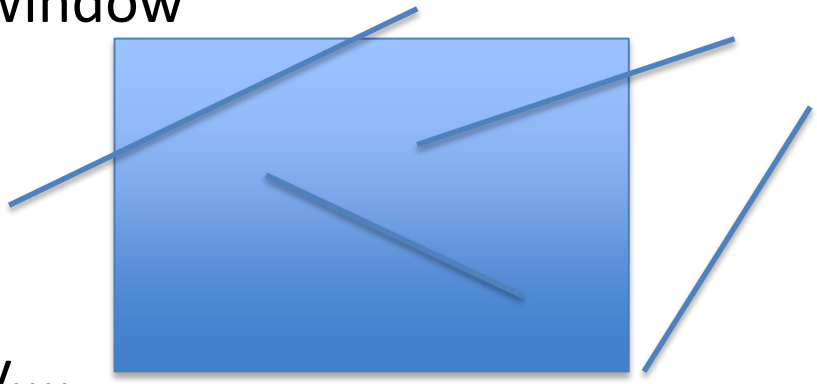
# Clipping

- Objects in the scene possibly will be completely
  - (a) inside the window,
  - (b) outside the window,

  Or (c) partially visible through the window



- Why ?

  Because of reducing time complexity....
  - Reduce time complexity to avoid the scan converting pixels outside window
  - Therefore, avoid time and iteration because of rasterizing outside of framebuffer bounds

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# 2D Clipping algorithms

- **Cohen-Sutherland Algorithm (Line)**
- **Liang-Barsky algorithm (Line)**
- **Sutherland-Hodgeman Algorithm (Polygon)**

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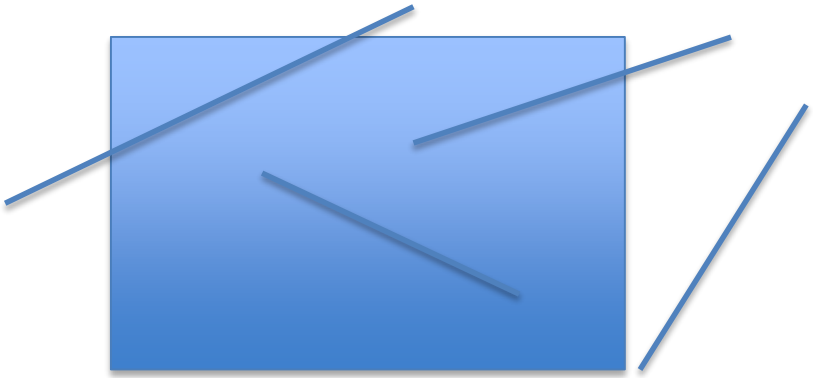
# Line Clipping

**Possible Configuration:**

1.Both endpoints are inside the region

- No clipping necessary



2.One endpoint in, one out

- Clip at intersection point

3.Both endpoints outside the region:

a. No intersection

b. Line intersects the region

- Clip line at both intersection points

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# Line Clipping: Cohen-Sutherland Algorithm

- Concept: Let a line with end point pairs $(x_1, y_1)$ and $(x_2, y_2)$
  - Trivial Accept/Rejects
  - Initial tests on a line for acceptance or rejection:
    - Determine whether intersection calculations is required.
  - If neither be trivially accepted nor rejected, this line is divided into two segments at a clip edge. Thus, one segment can be trivially rejected.


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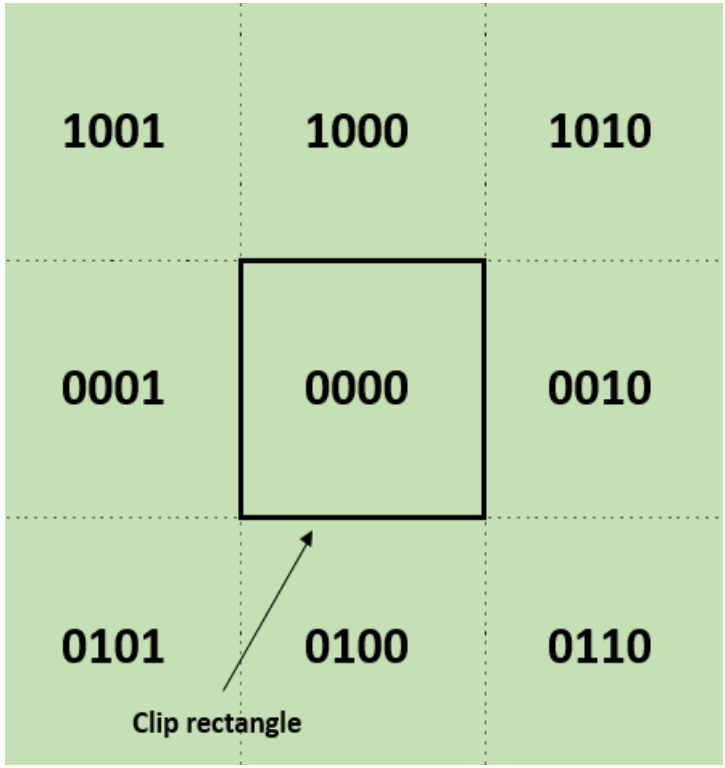
# Cohen-Sutherland Algorithm

- Assign a 4-bit region code to each endpoint $c_0, c_1$

**Bit1 = 1 if** $y > y_{max}$ i.e. 1000
**Bit2 = 1 if** $y < y_{min}$ i.e. 0100
**Bit3 = 1 if** $x > x_{max}$ i.e. 0010
**Bit4 = 1 if** $x < x_{min}$ i.e. 0001
==========

**Algorithm:** accept/reject
**if** $(c_0 \mid c_1) = 0000$
accept (draw)
**else if** $(c_0 \ \& \ c_1) \neq 0000$
reject (don't draw)
**else** clip using **intersection points**
and retest

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# Intersect point

- If 1000, intersect with line $y=y_{max}$
- If 0100, intersect with line $y=y_{min}$
- If 0010, intersect with line $x=x_{max}$
- If 0001, intersect with line $x=x_{min}$

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# Intersect Point $(x_i, y_i)$

$$x_i = x_{\min} \text{ or } x_{\max}$$

$$y_i = y_1 + m(x_i - x_1)$$

} If edge line is vertical

OR

$$x_i = x_1 + (y_i - y_1)/m$$

$$y_i = y_{\min} \text{ or } y_{\max}$$

} If edge line is horizontal

$$\textit{where,} \quad m = (y_2 - y_1)/(x_2 - x_2)$$

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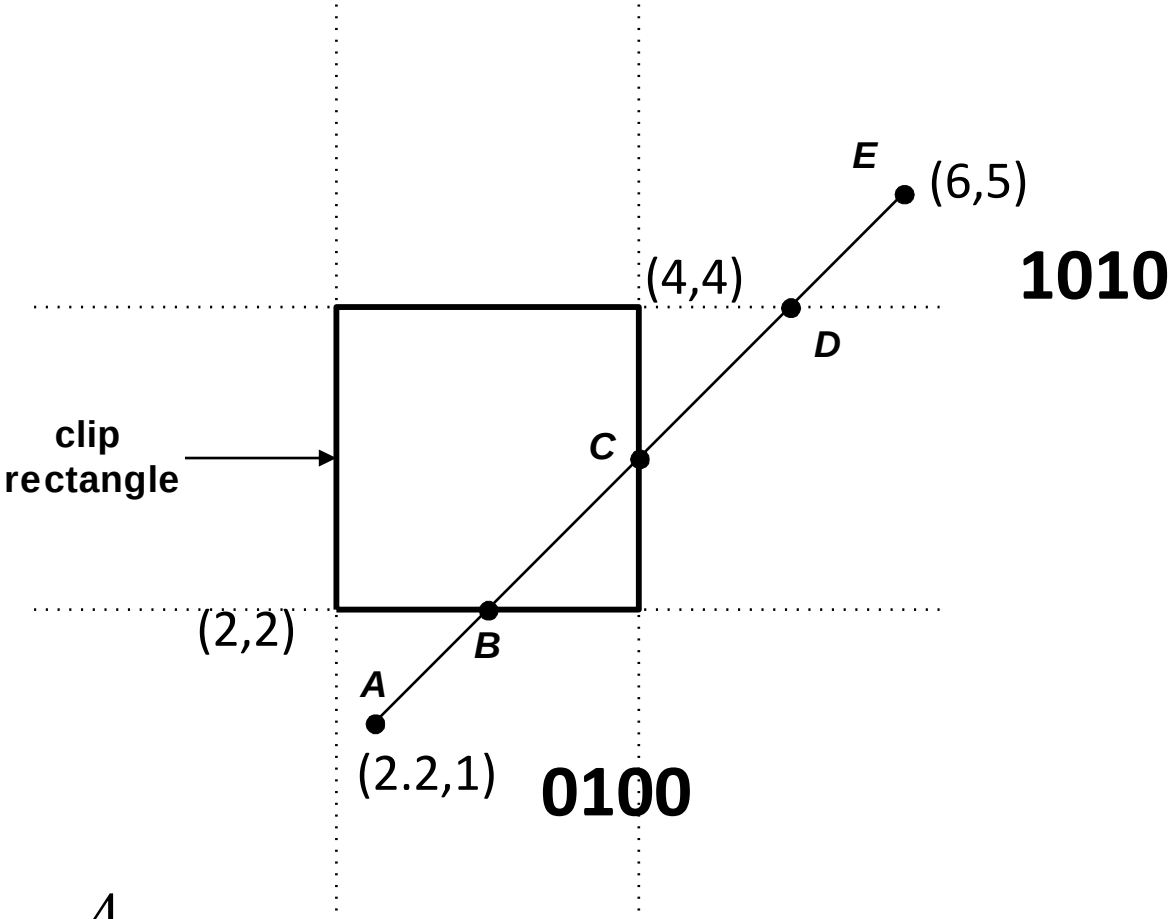
# Cohen-Sutherland Algorithm




$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{5-1}{6-2.2} = \frac{4}{3.8} = 1.05$$

An Example

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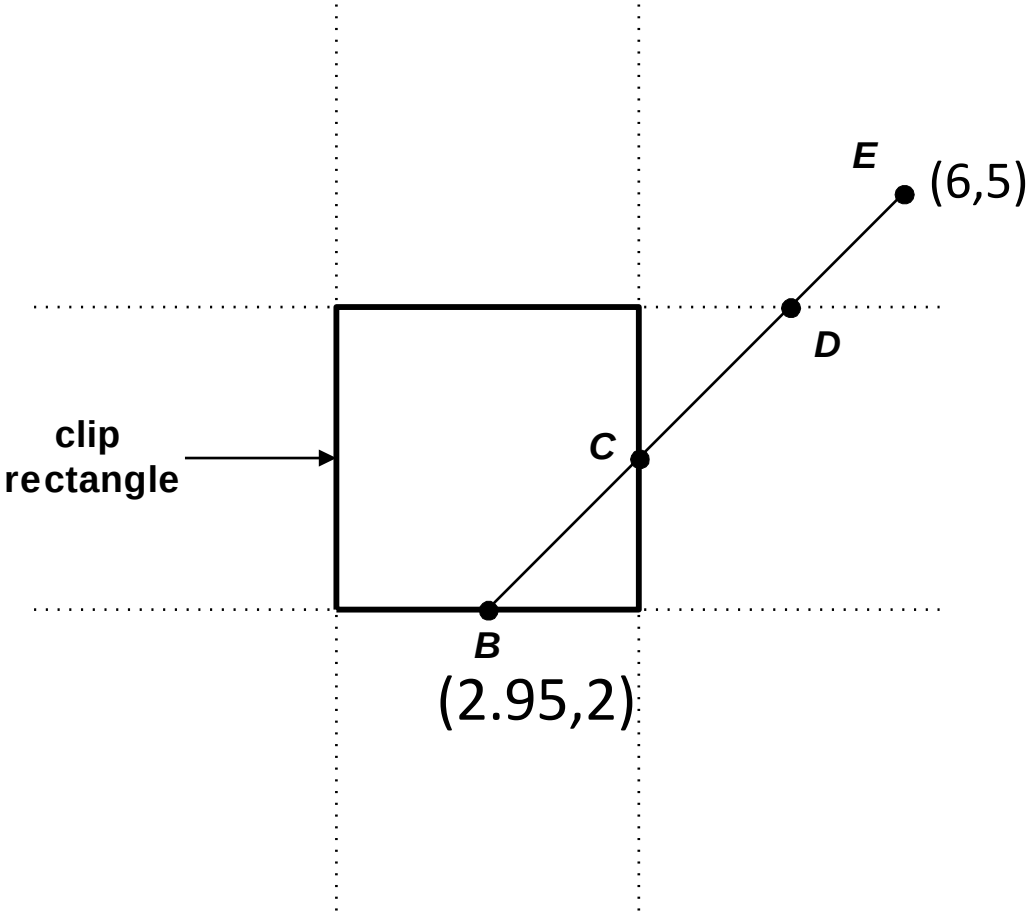
# Cohen-Sutherland Algorithm




An Example

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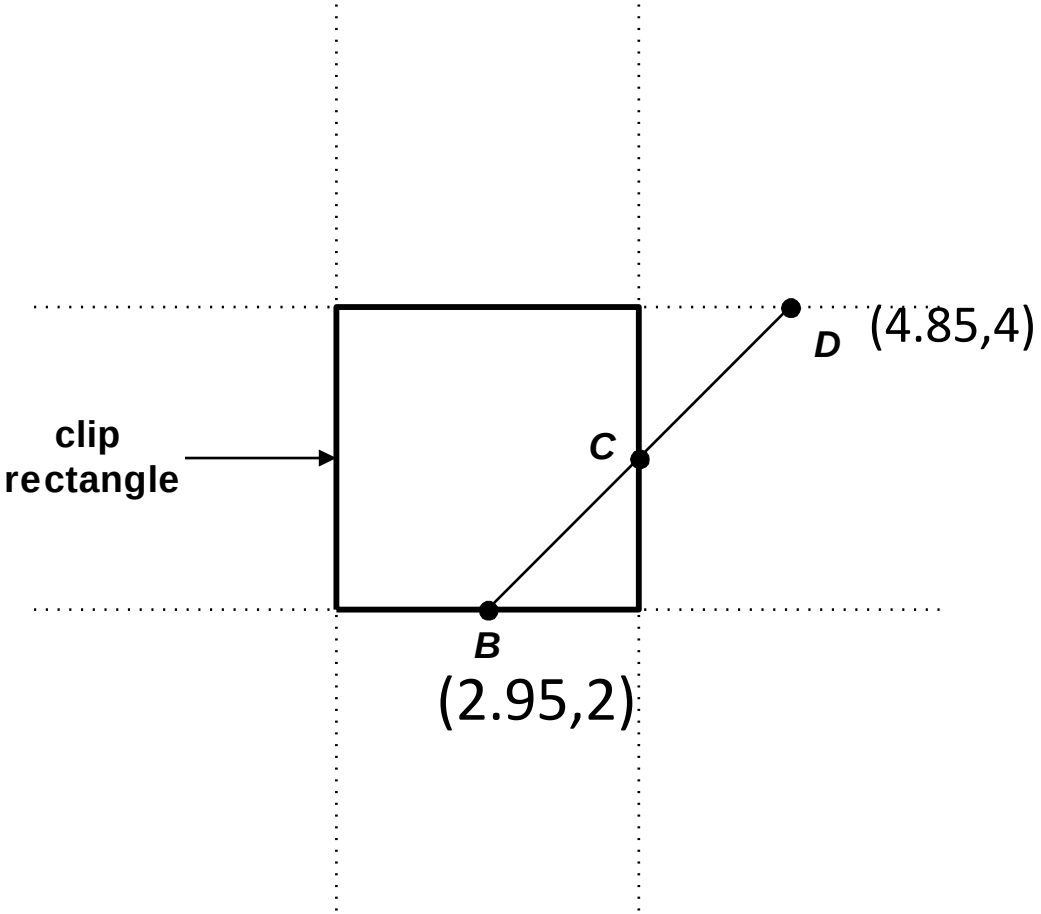


An Example

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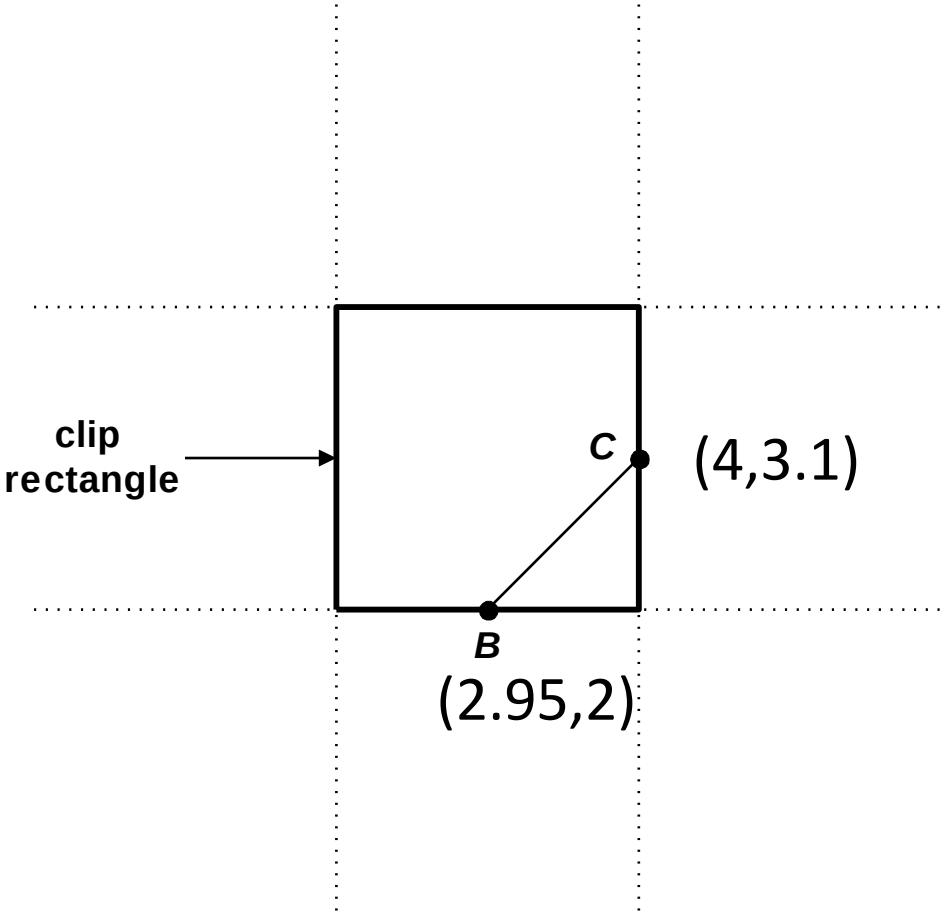
# Cohen-Sutherland Algorithm




An Example



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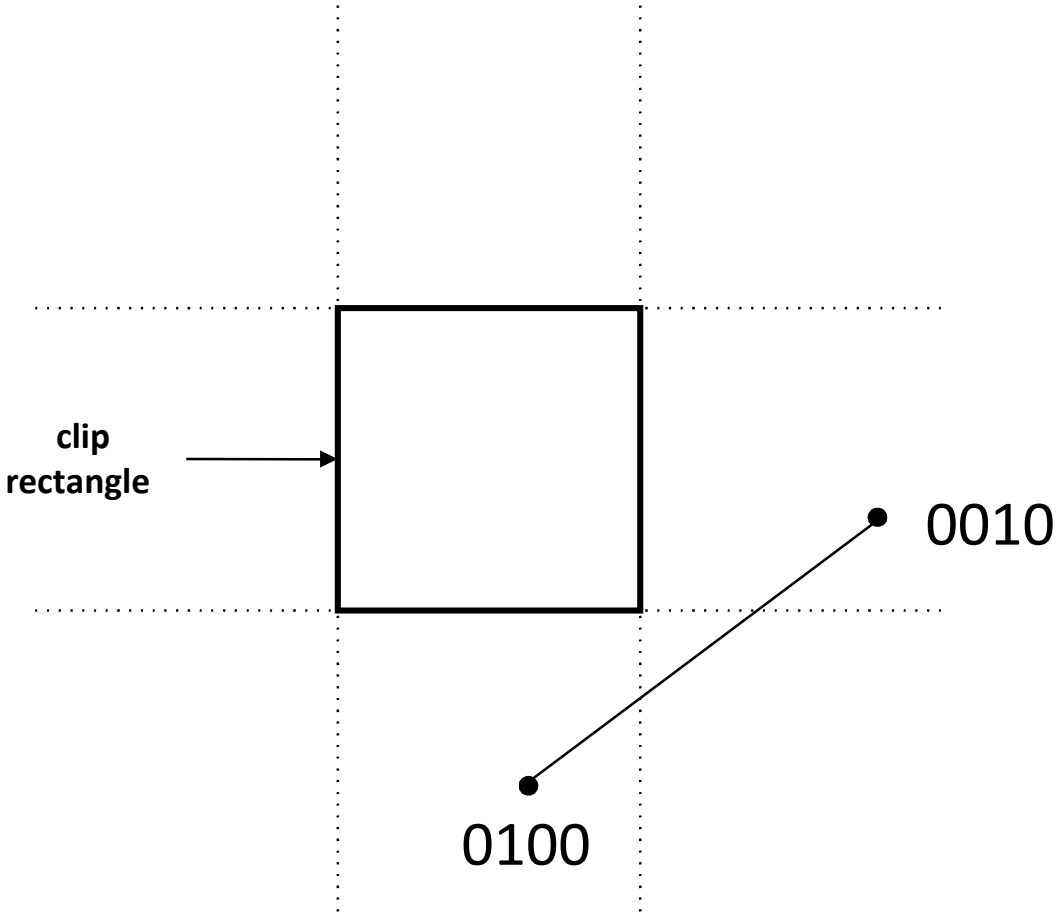
# Another Example

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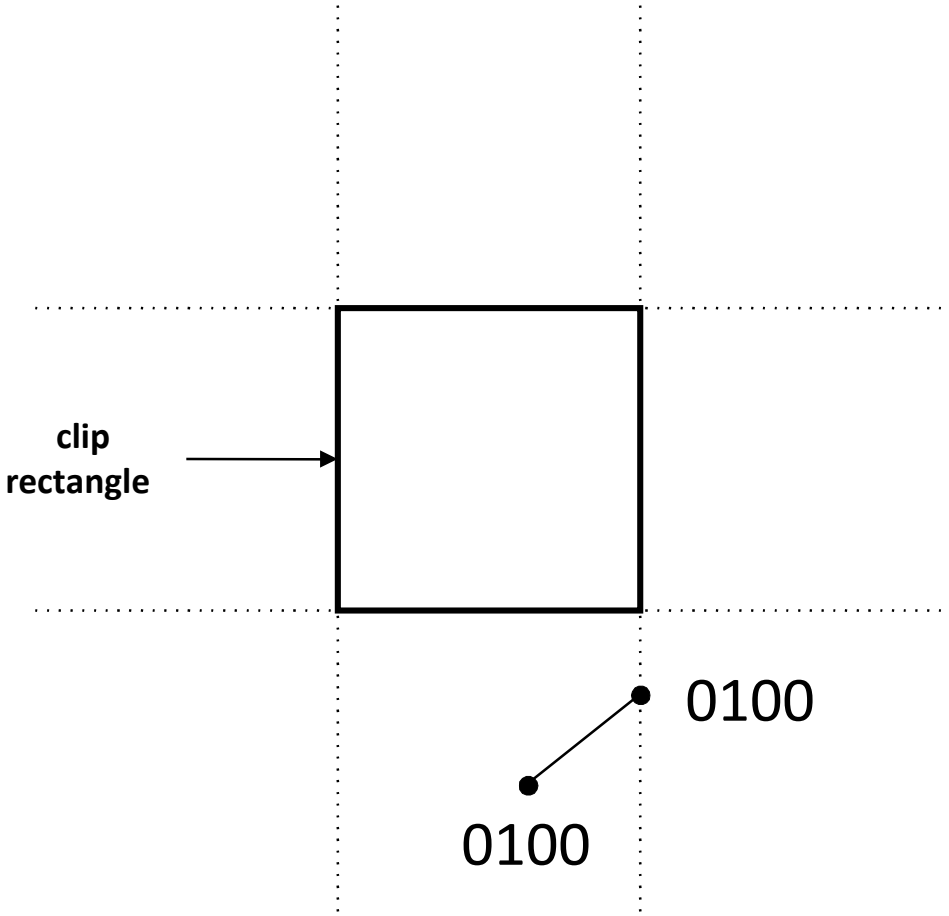
# Another Example

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