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Computer Graphics

2D Viewing and Clipping

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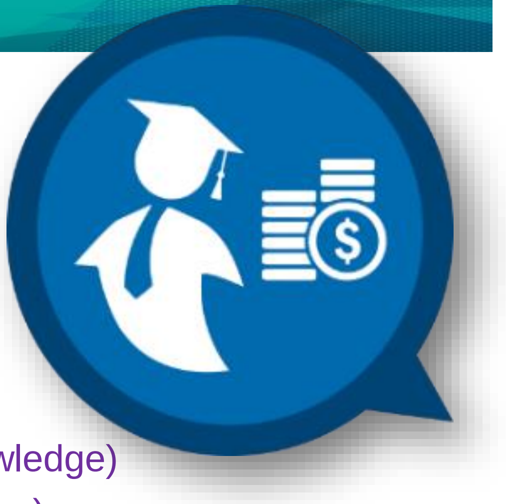
Chapter Description



- Aims
  - Basic of Computer Graphics.

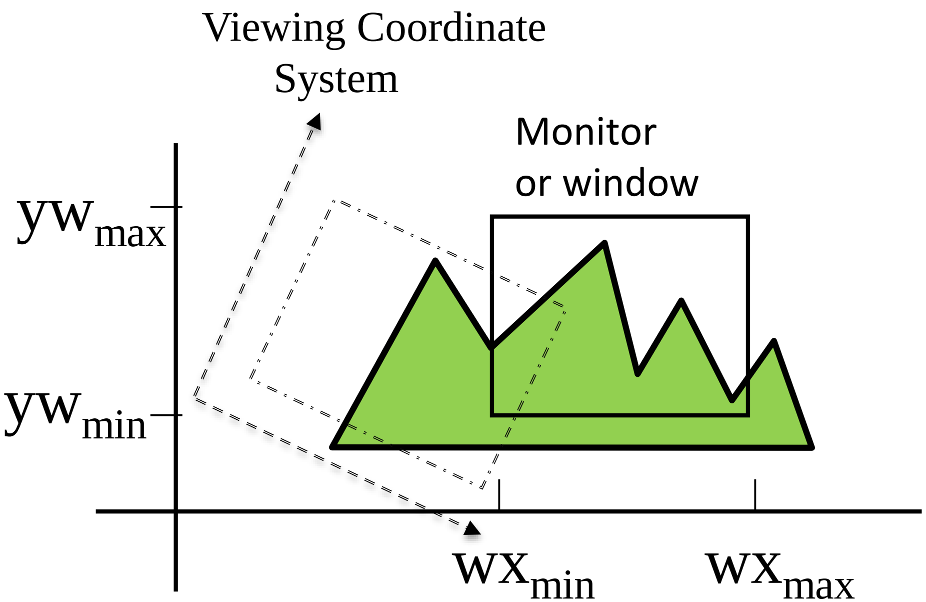
- Expected Outcomes
  - Understand the basic concept of computer graphics. (CO1: Knowledge)
  - Ability to use the computer graphics technology. (CO1: Knowledge)

- References

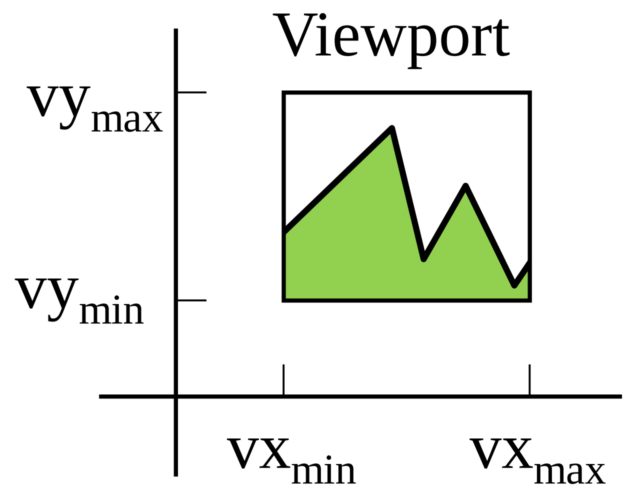
  - Computer Graphics by Zhigang Xiang, Schaum’s Outlines.
  - Donald Hearn & M. Pauline Baker, Computer Graphics with OpenGL, 4th Edition, Boston : Addison Wesley, 2011.

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?



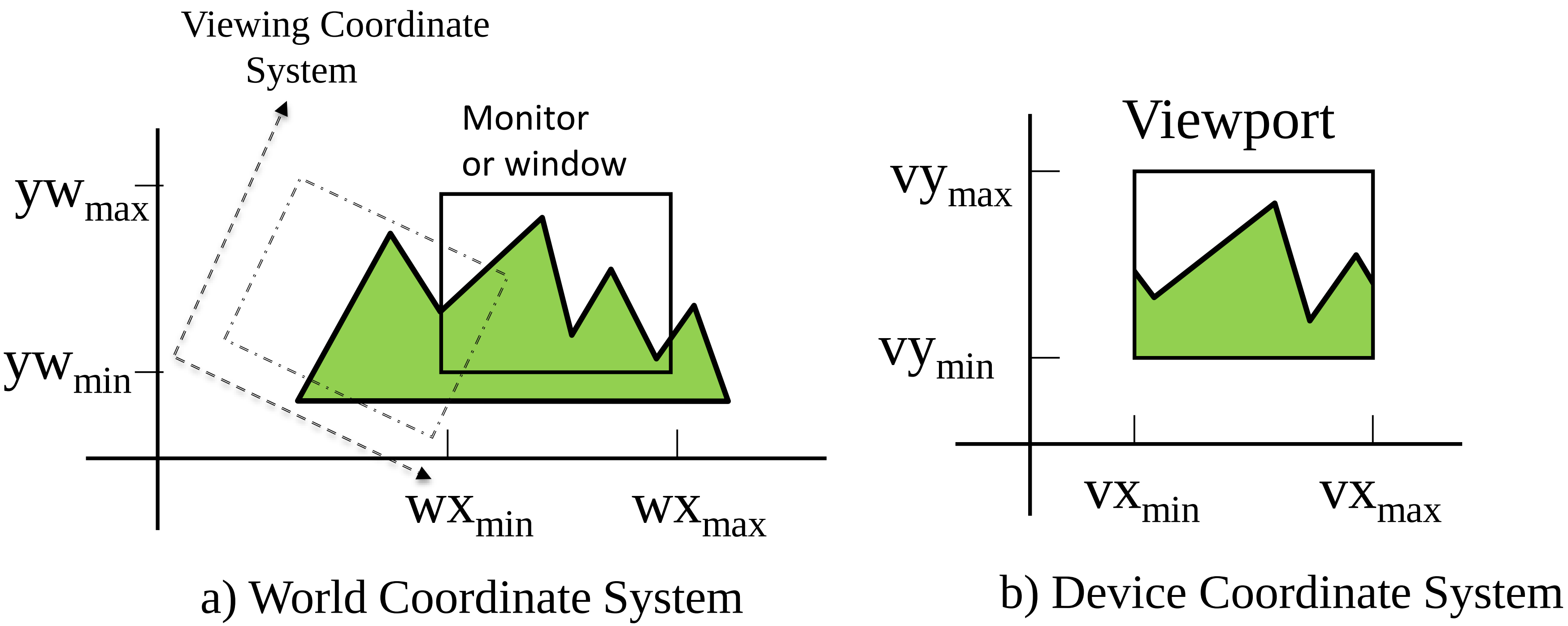
a) World Coordinate System



b) Device Coordinate System

Viewing transformation

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



Clipping

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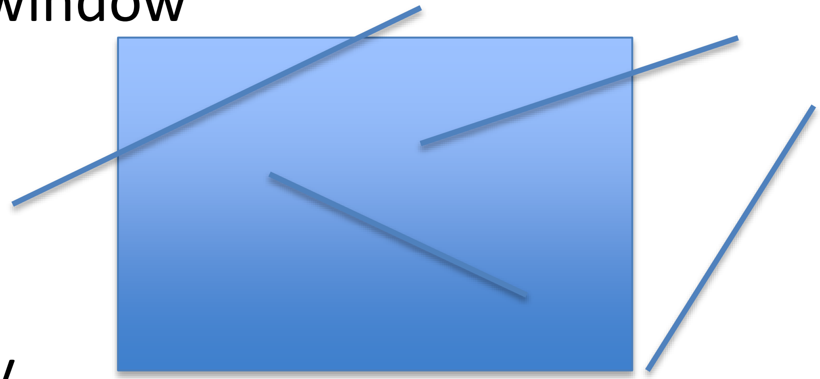
- Objects in the scene possibly will be completely

  (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

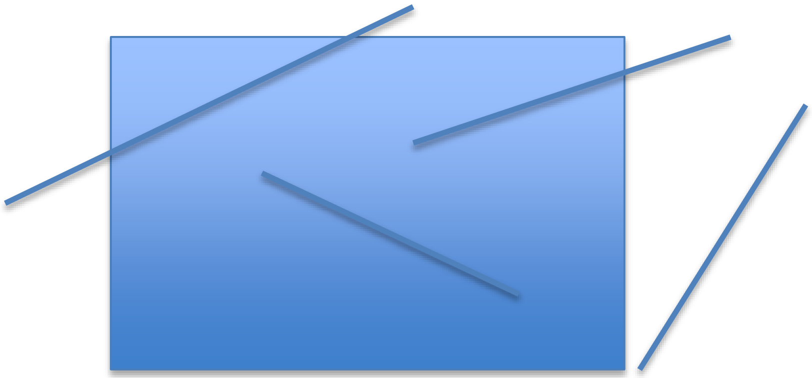
2D Clipping algorithms

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

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

Line Clipping: Cohen-Sutherland Algorithm

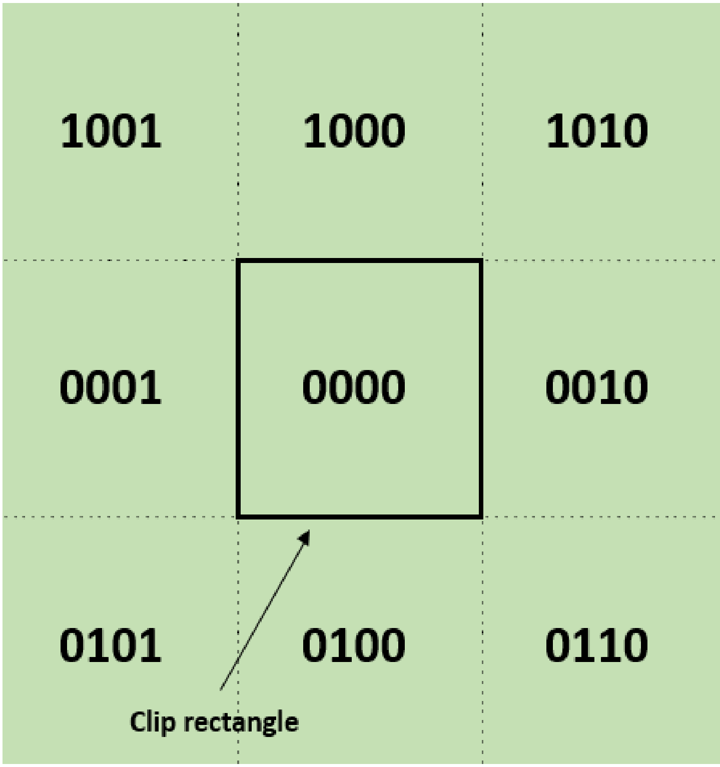
- Concept: Let a line with end point pairs (x_1, y_1) and (x_2, y_2)
  - Trivial Accept/Rejects
  - Initial tests on a line for acceptance or rejection:
    - Determine whether intersection calculations is required.
  - If neither be trivially accepted nor rejected, this line is divided into two segments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

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



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 $x=x_{min}$

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

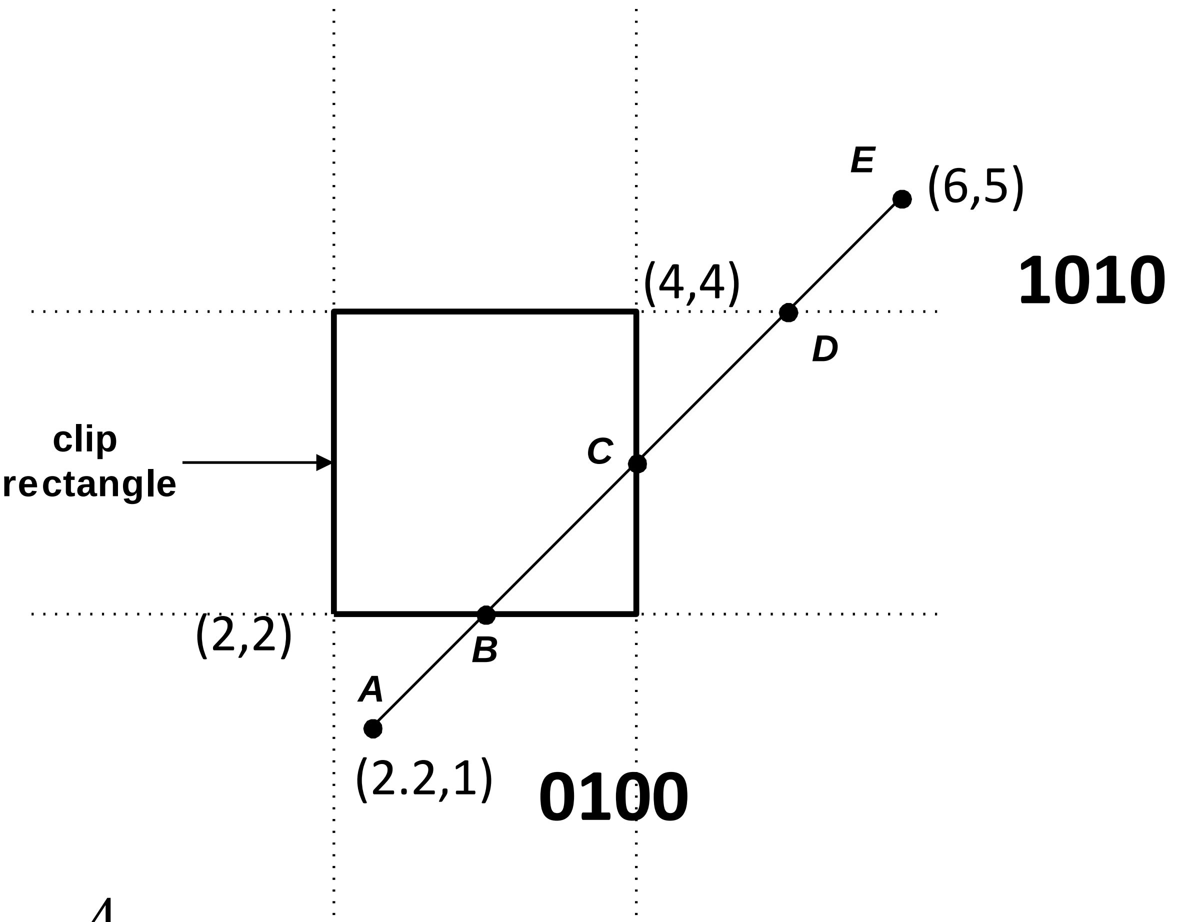
$$x_i = x_1 + (y_i - y_1)/m$$

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

If edge line is horizontal

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

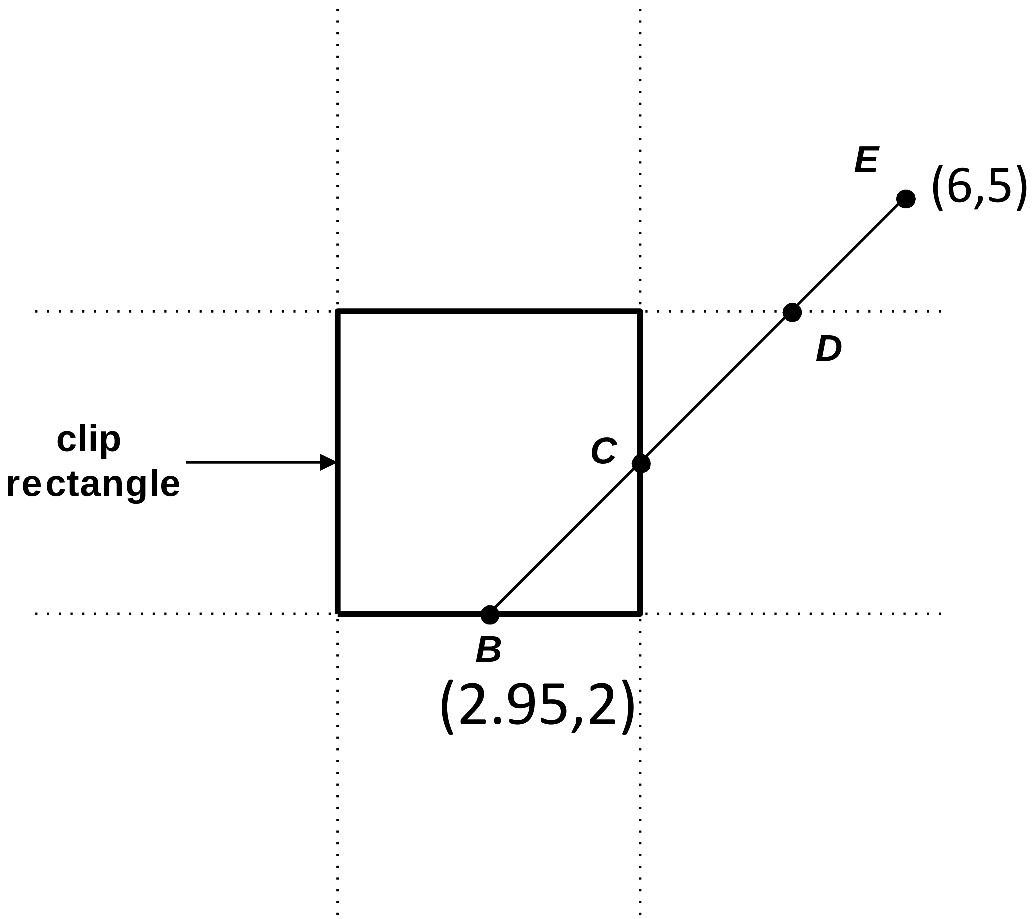
Cohen-Sutherland Algorithm



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

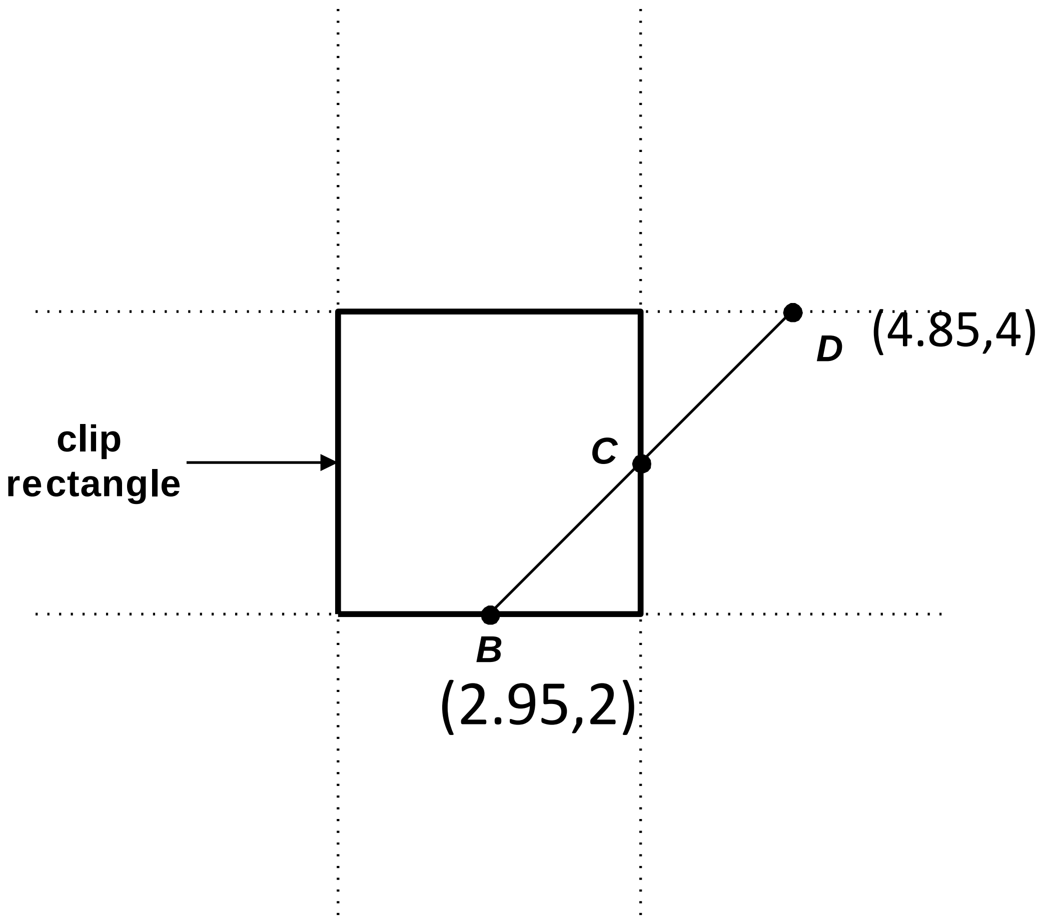
An Example

Cohen-Sutherland Algorithm



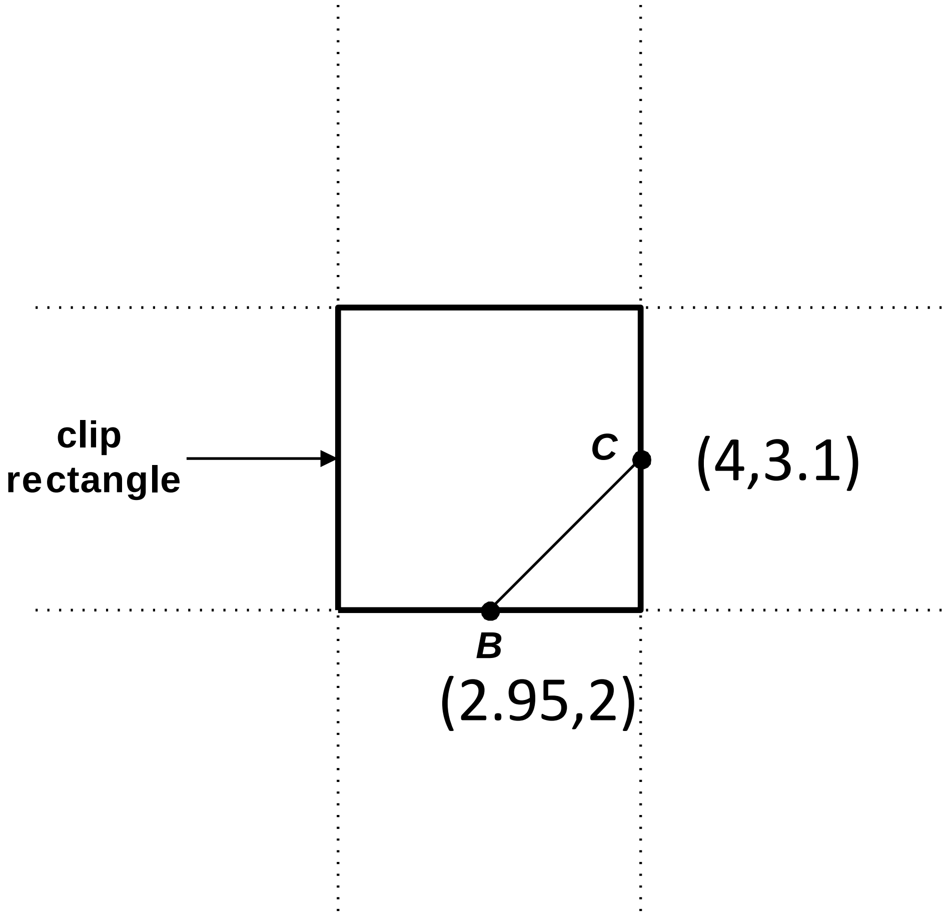
An Example

Cohen-Sutherland Algorithm



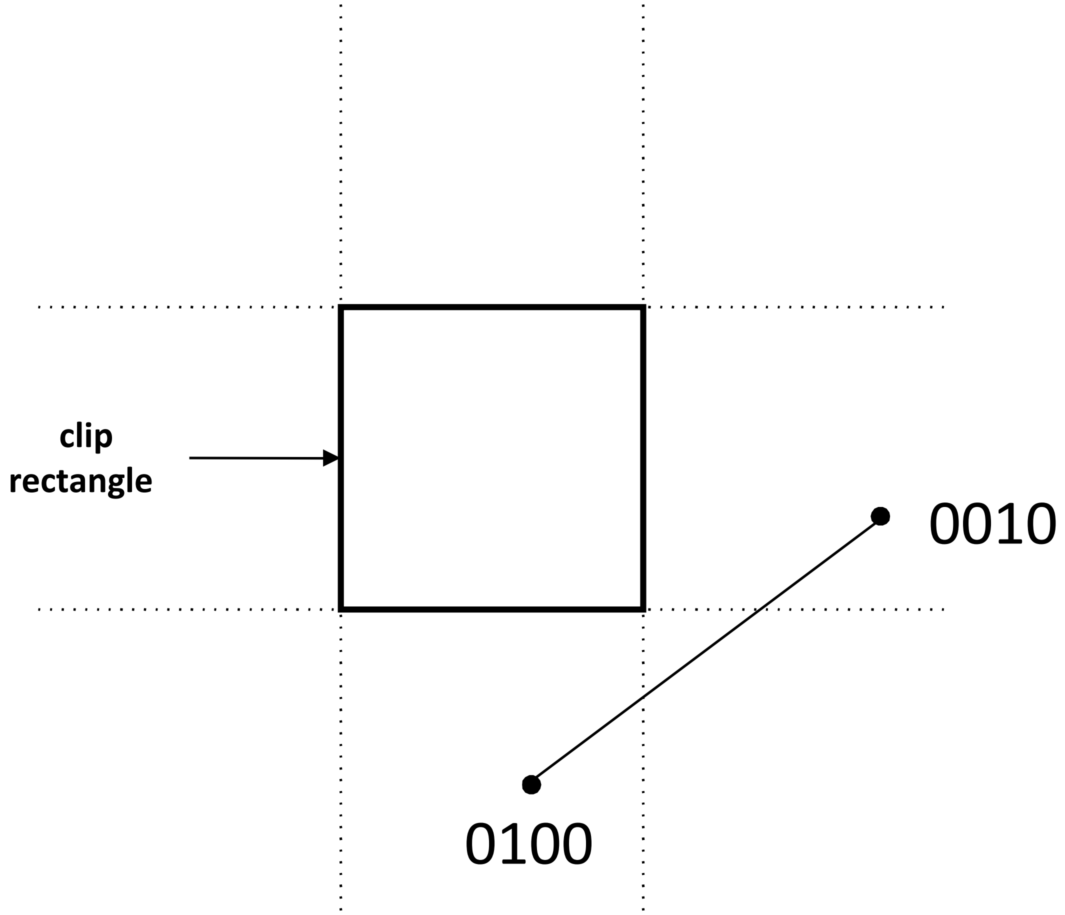
An Example

Cohen-Sutherland Algorithm



An Example

Another Example



Another Example