Viewing & Clipping

Computer Graphics

SYBScIT Sem III

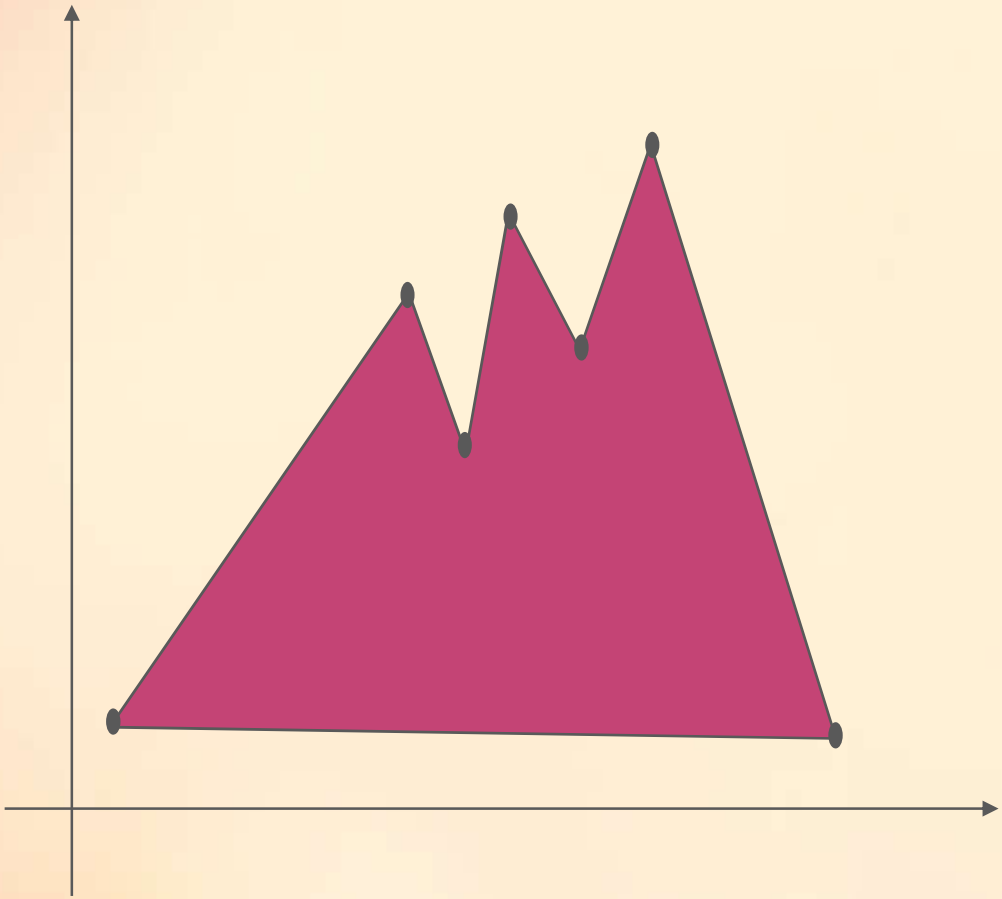
Topics to be covered

- Basic terminologies
- Viewing transformations

Basic terminologies

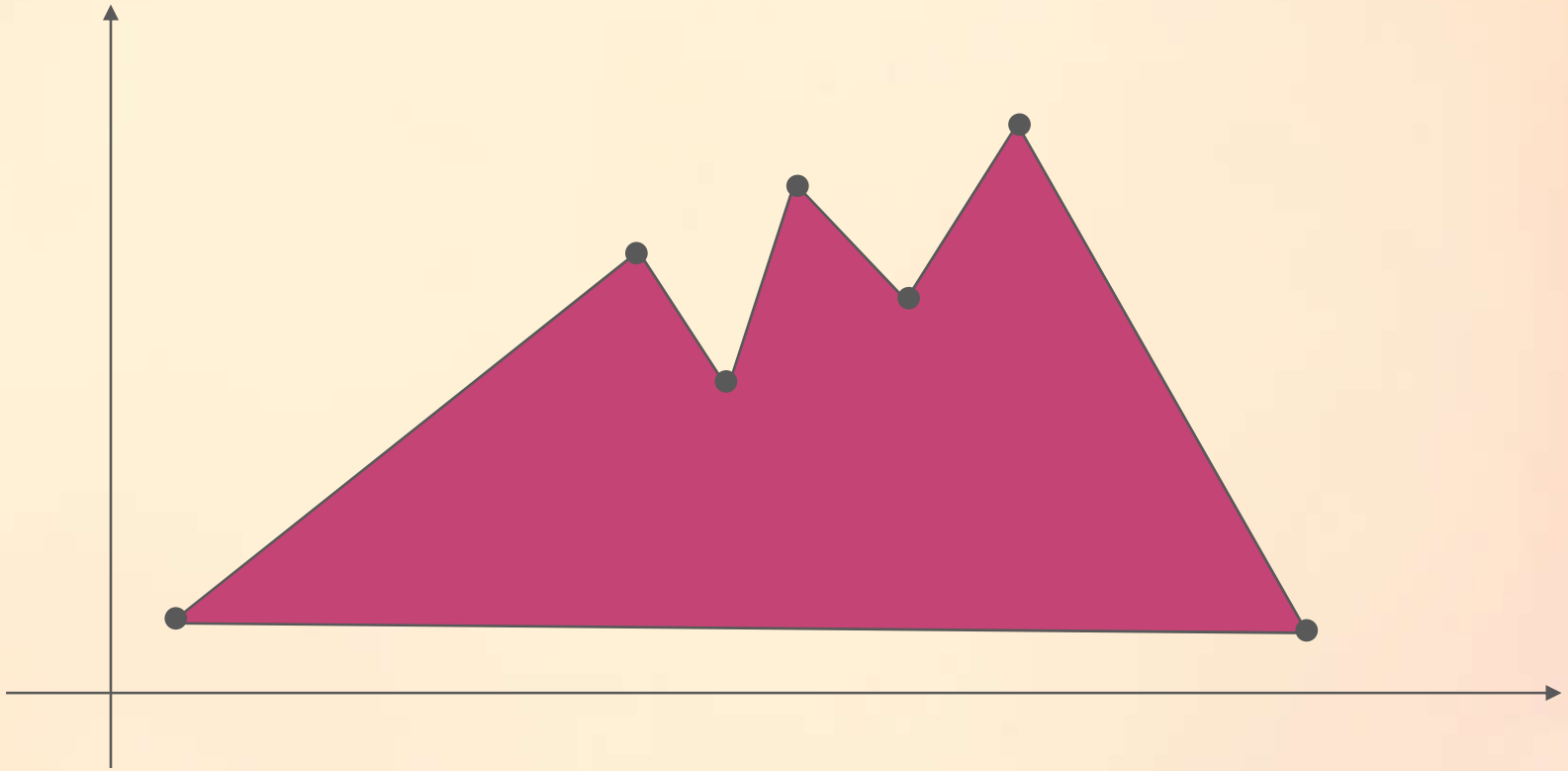
- Windowing
- View, Viewing & Viewing Area
- Clipping

Windowing



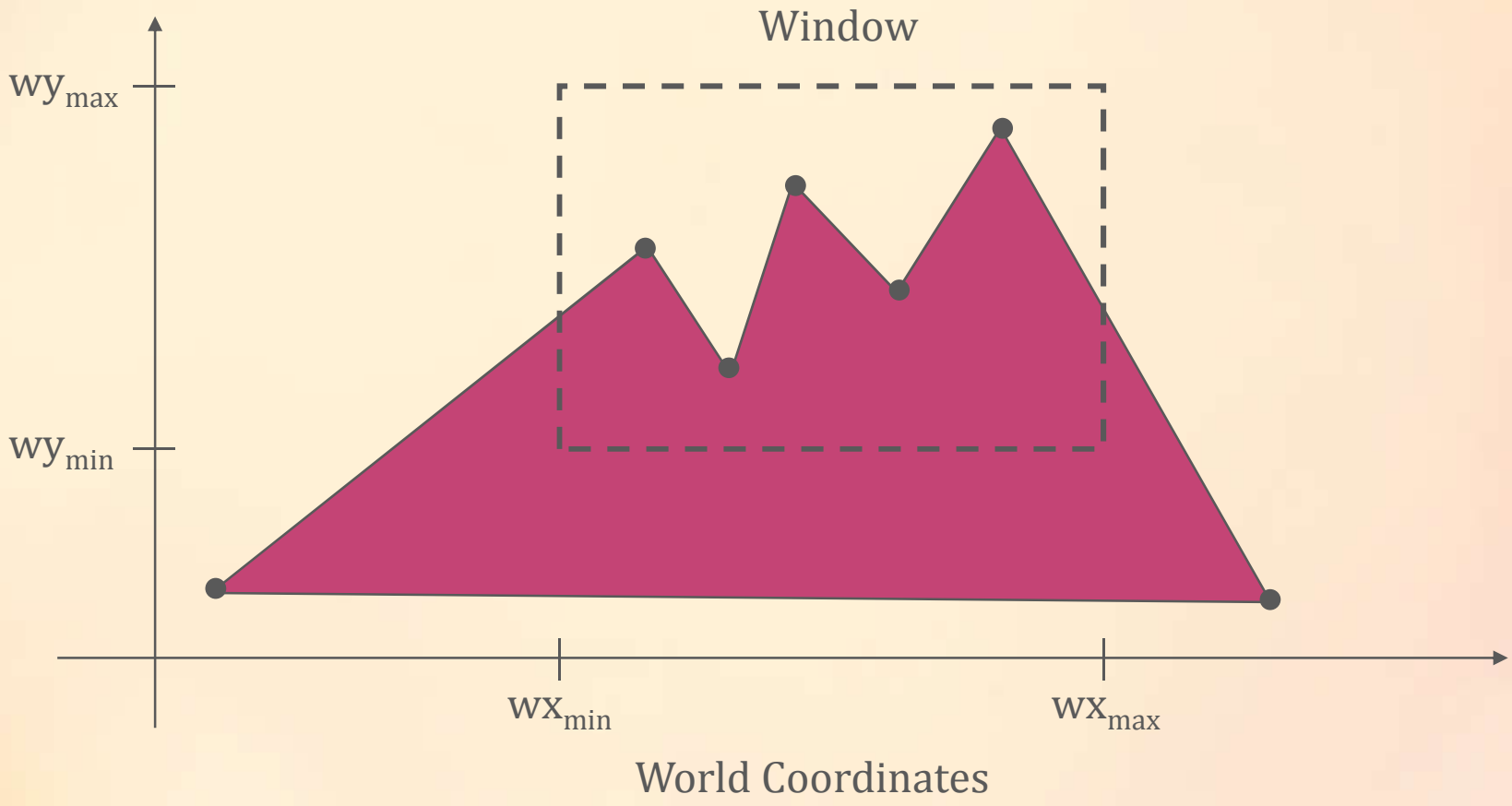
- A scene is made up of a collection of objects
- The process of selecting the area of interest in the scene and viewing that selected area is called **windowing**
- The part of the scene visible after windowing is called **view**
- The area where the view is being displayed is called **viewing area**

- Windowing divides a scene into two regions:
  - **Visible Region** – that region which gets displayed in viewing area
  - **Not Visible Region** – the region which does not gets displayed in viewing area
- The not visible are is said to be **CLIPPED**
- **Clipping**
- The process of removing unwanted part of a scene and selecting the visible portion and displaying it

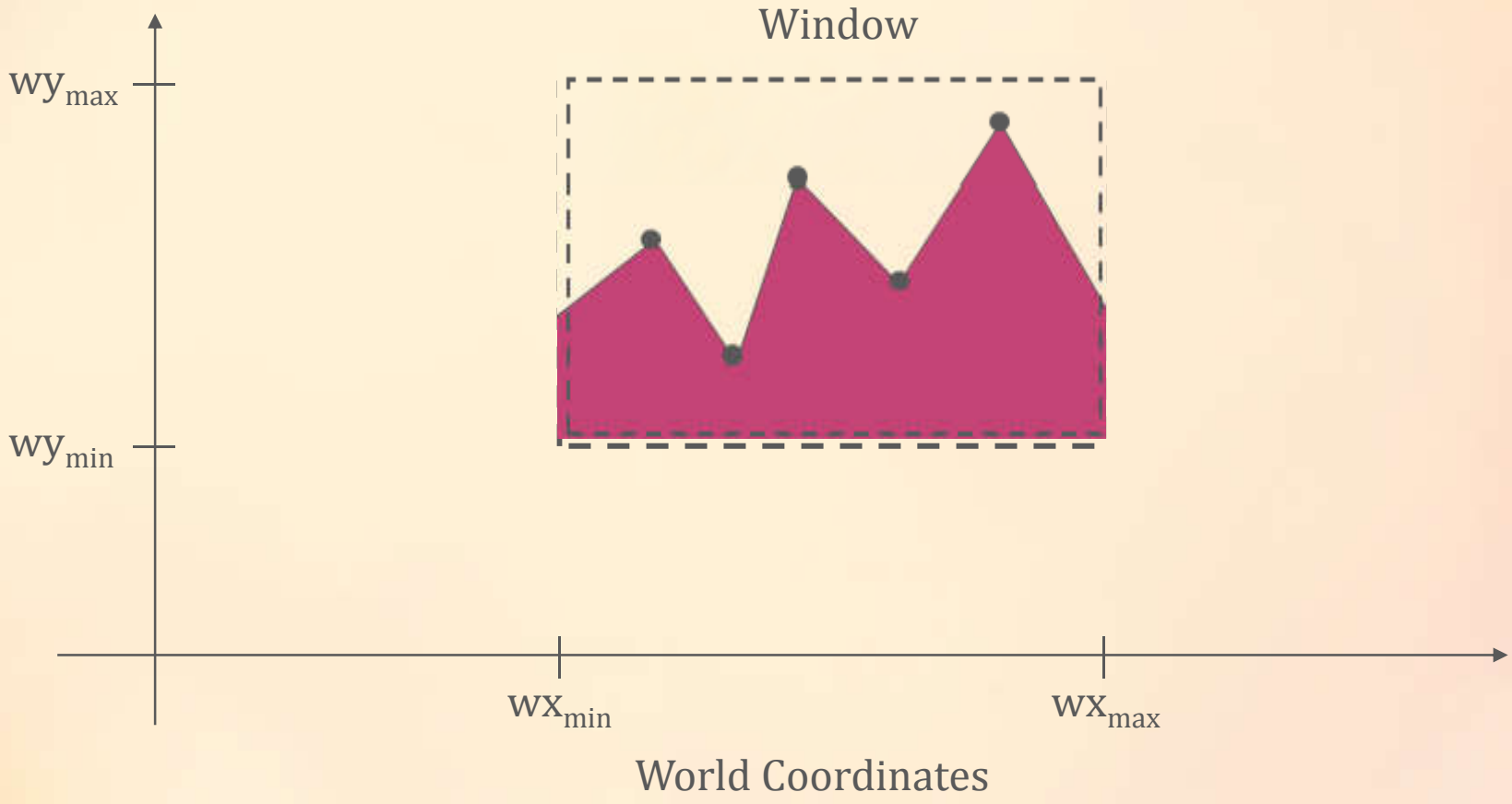


World Coordinates

- When we display a scene only those objects within a particular window are displayed



- Because drawing things to a display takes time we *clip* everything outside the window



Topics to be covered

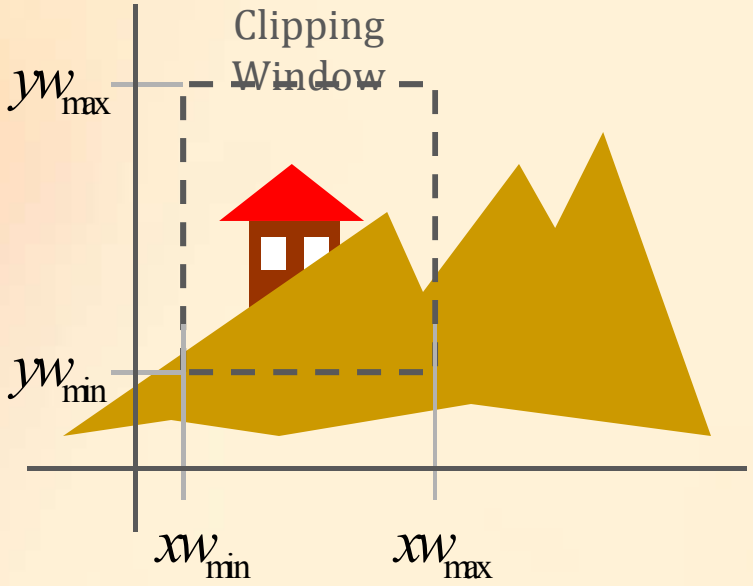
- Basic terminologies
- Viewing transformations
- Clipping

Viewing transformations

Terms involved

- WCS
- PDCS
- NDC
- MAPPING WCS TO PDCS
- WINDOW & VIEWPORT
- STEPS IN A 2D VIEWING PIPELINE

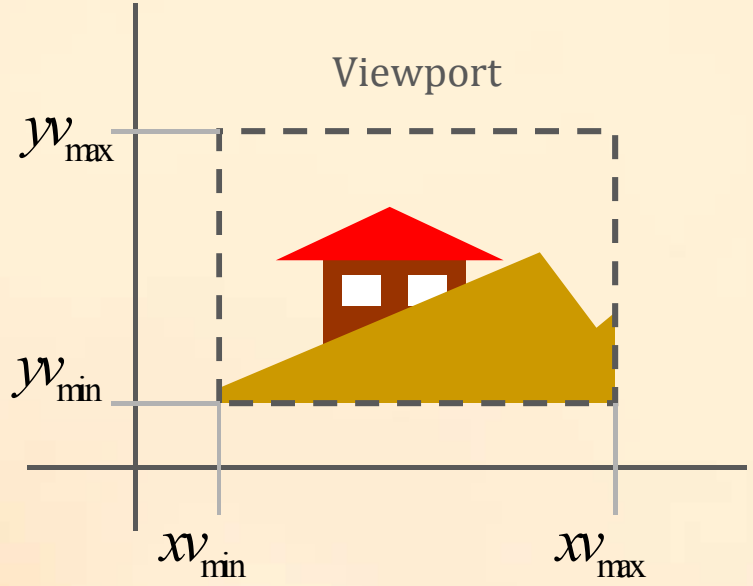
- An image is stored in memory of a computer in world coordinate system (WCS)
- This image is displayed on a physical device and is measured using the physical device co-ordinate system (PDCS) corresponding to that physical device
- Displaying an image involves mapping of coordinates of the objects of the image from the image to the appropriate physical device coordinates where the image is supposed to be displayed.
- This mapping from WCS to PDCS is called Viewing Transformation and is achieved using co-ordinate transformations.



World Coordinates

The clipping window is mapped into a viewport.

Viewing world has its own coordinates, which may be a non-uniform scaling of world coordinates.



Viewport Coordinates

The area of interest in WCS is called window

The area of display on the physical device wh
Selected image is to be displayed is called vie

STEPS IN A 2D VIEWING PIPELINE

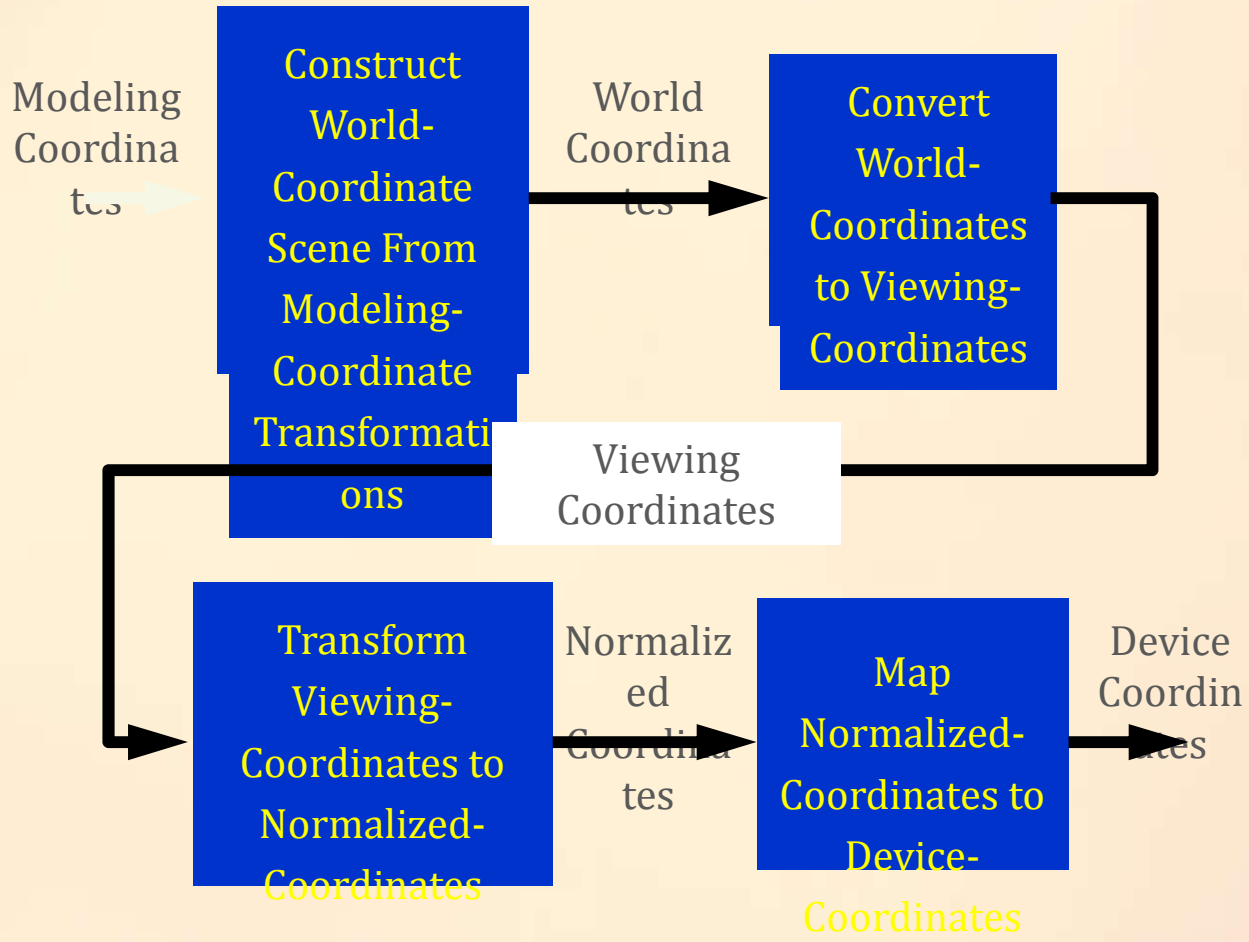
a) Construct a World Coordinate Scene using Model Coordinate Transformations

b) Convert world co-ordinates to viewing coordinates (clipping window)

c) Transform viewing coordinates to normalized coordinates

d) Map normalized coordinates to device coordinates

2D viewing transformation pipeline



Topics to be covered

- Basic terminologies
- Viewing transformations
- Clipping

- CLIPPING
  - INTRODUCTION AND DEFINITION
  - POINT CLIPPING
  - LINE CLIPPING
  - POLYGON CLIPPING
  - TEXT CLIPPING

Clipping

- Windowing divides a scene into two regions:
  - **Visible Region** – that region which gets displayed in viewing area
  - **Not Visible Region** – the region which does not gets displayed in viewing area
- The not visible are is said to be **CLIPPED**
- **Clipping**
  - The process of removing unwanted part of a scene and selecting the visible portion and displaying it
  - **Clipping** is any procedure that identifies portion of a picture that are either inside or outside a specified region referred to as a clip window

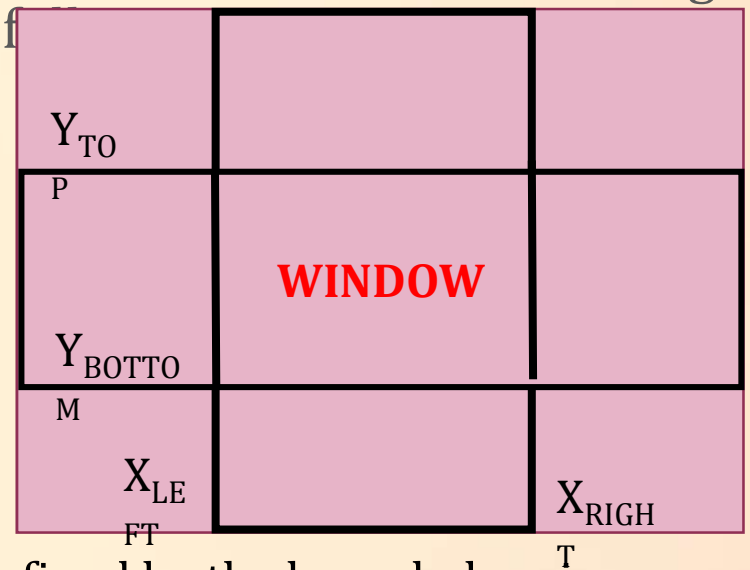
- Clipping window may be rectangular, circular or any arbitrary shape but for computing purpose rectangular windows are used.
- Most techniques are based on window that is defined using set of four lines that define the f

$x=x_{right}$,

$x=x_{left}$

$y=y_{top}$

$y=y_{bottom}$

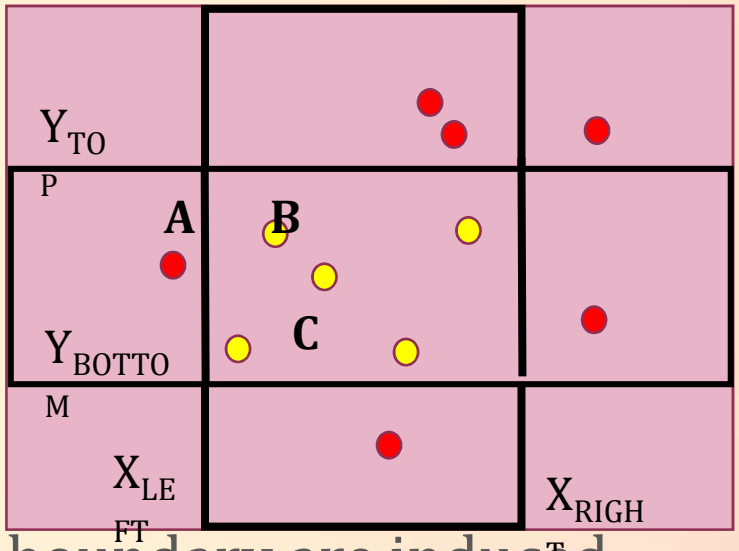


- The visible portion of a window is defined by the bounded region between these four lines

- In computer graphics, clipping is implemented using clipping algorithms
- A clipping algorithm determines whether points. Lines or portions of the lines are within the clipping window.
- Points and lines within the window are retained for display and all other points and lines are discarded.

POINT CLIPPING

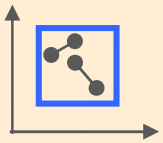
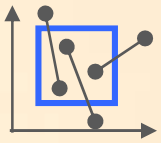
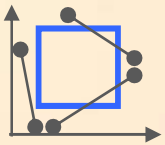
- A point clipping algorithm finds all the points that are interior to a clipping window.
- Any point (x,y) is said to be inside the clipping window if it satisfies the visibility test given by:
  - $x >= x_{left}$, $x <= x_{right}$
  - $y >= y_{bottom}$, $y <= y_{top}$



- All the points on the window boundary are induced within the window

Line Clipping

- It is the process of removing lines or portions of line outside of clipping window.
- Line clipping algorithms examine the end-points of each line to see if they are in the window or not

Situation	Solution	Example
Both end-points inside the window	Don't clip	
One end-point inside the window, one outside	Must clip	
Both end-points outside the window	Don't know!	

Line Clipping algorithms

- Brute Force Line Clipping
- Cohen-Sutherland Clipping Algorithm

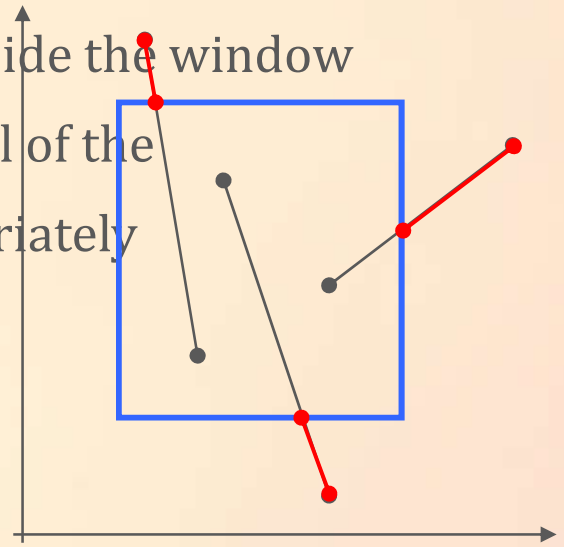
Brute Force Line Clipping

- Brute force line clipping can be performed as follows:
  - Don't clip lines with both end-points within the window
  - For lines with one end-point inside the window and one end-point outside,

    calculate the intersection point (using the equation of the line) and clip from this point out
  - For lines with both end-points outside the window

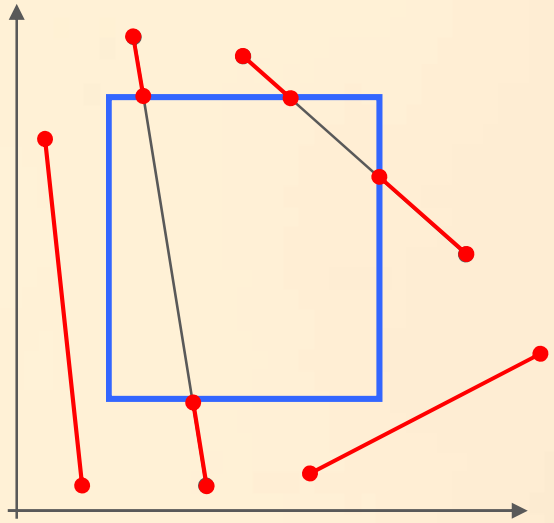
    test the line for intersection with all of the

    window boundaries, and clip appropriately



Disadvantage

- Calculating line intersections is computationally expensive, because a scene can contain so many lines, the brute force approach to clipping is much too slow

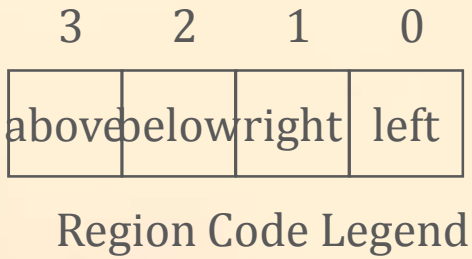


Cohen-Sutherland Clipping Algorithm

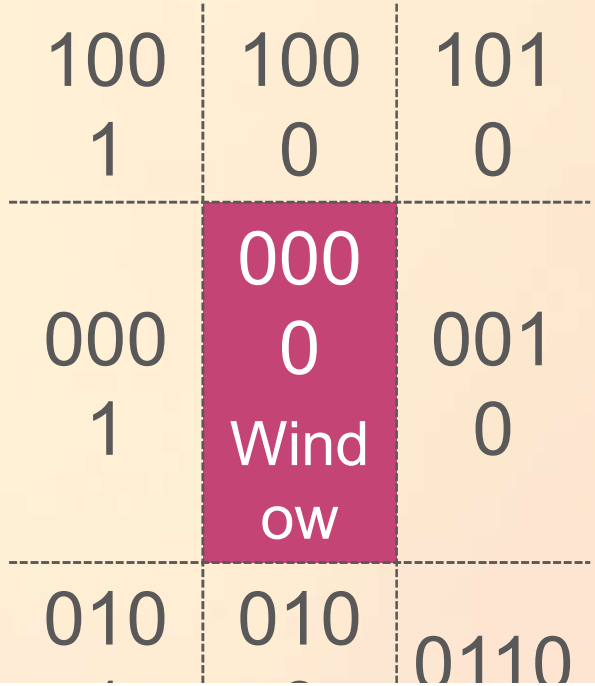
- An efficient line clipping algorithm
- The key advantage of the algorithm is that it vastly reduces the number of line intersections that must be calculated

World Division

- World space is divided into regions based on the window boundaries
  - Each region has a unique four bit region code
  - Region codes indicate the position of the regions with respect to the window

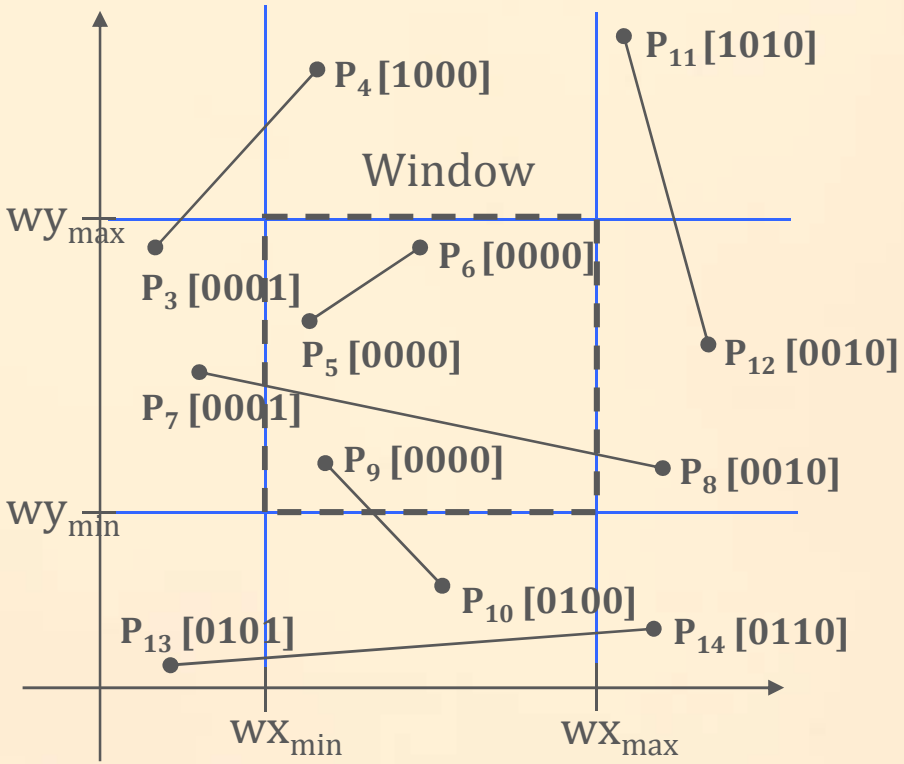


Region Code Legend



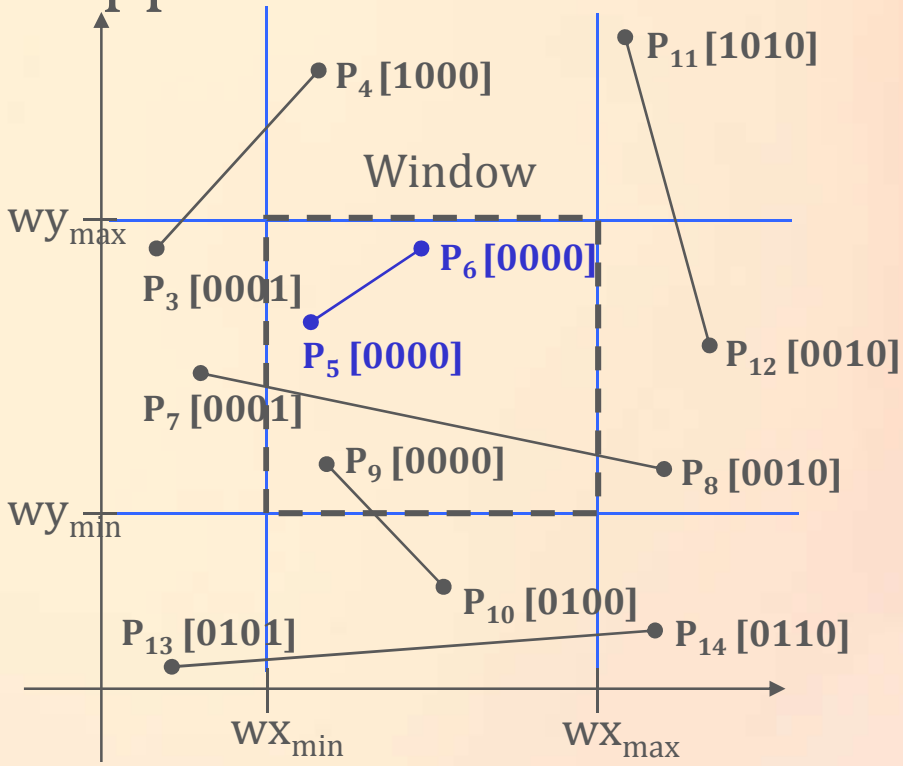
Labelling

- Every end-point is labelled with the appropriate region code



Lines In The Window

- Lines completely contained within the window boundaries have region code [0000] for both end-points so are not clipped



Lines Outside The Window

- Any lines with a common set bit in the region codes of both end-points can be clipped
  - The AND operation can efficiently check this