Two Dimensional Viewing

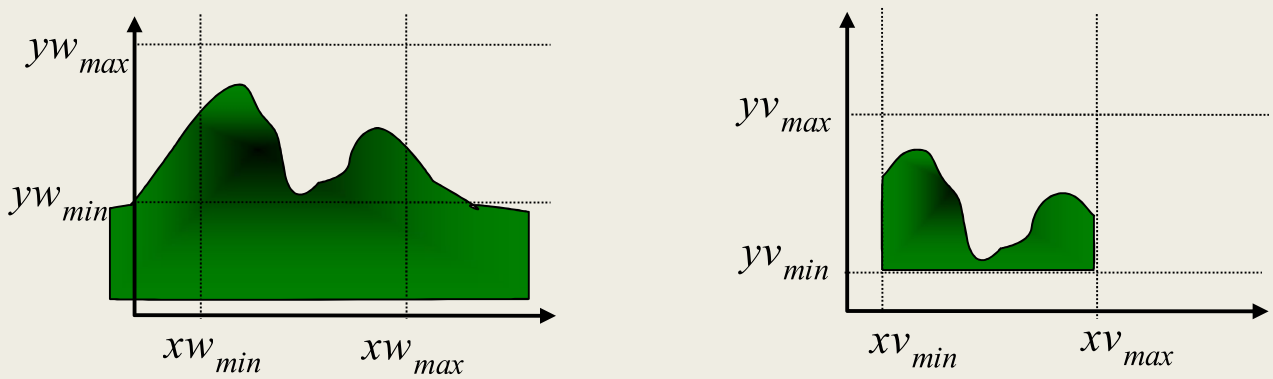
The Viewing Pipeline

- Graphics package allows the user to specify which part of a defined picture to be displayed where that part is to displayed on the display device
- **Window**
  - *A world-coordinate area selected for display.*

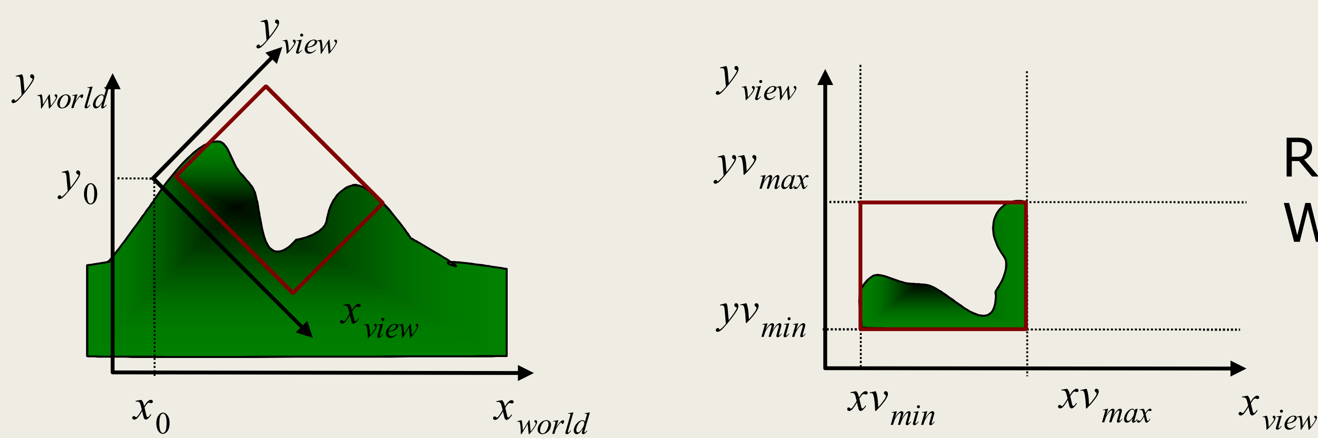
    defines what is to be viewed
- **Viewport**
  - *An area on a display device to which a window is mapped.*

    defines where it is to be displayed
- **Viewing transformation**
  - *The mapping of a part of a world-coordinate scene to device coordinates.*
  - *The two dimensional viewing transformation is referred as windowing transformations.*

Two-Dimensional Viewing



Rectangular Window



Rotated Window

Two-Dimensional Viewing

- Rectangular window of different orientation viewing transformations follows the following steps
- Construct the scene in world coordinates using the output primitives and attributes.
- Obtain the particular orientation for the window, set up a two dimensional viewing coordinate system in the world coordinate plane and define a window in the viewing coordinate system.
- Once the reference frame is established transform the descriptions in world coordinates to viewing coordinates.
- We then define a viewport in normalized coordinates and map the viewing coordinate of the scene to normalized coordinates

1. Construct the scene in world coordinates with primitives and attributes.
2. Set up a 2D viewing coordinate system, defining a window in it.
3. Transform descriptions from world to viewing coordinates.
4. Define a viewport in normalized coordinates and map the scene to it.
5. Map the scene from normalized coordinates to various display devices.
6. Perform window-to-viewport transformations for each output device.
7. This mapping process is called workstation transformation.
8. The window is in normalized space, and the viewport is in display device coordinates.
9. This process controls how different parts of the scene appear on individual output devices.

The Viewing Pipeline

- All parts of the picture that lie outside the viewport are clipped .
- Contents of the viewport are transferred to device coordinates.

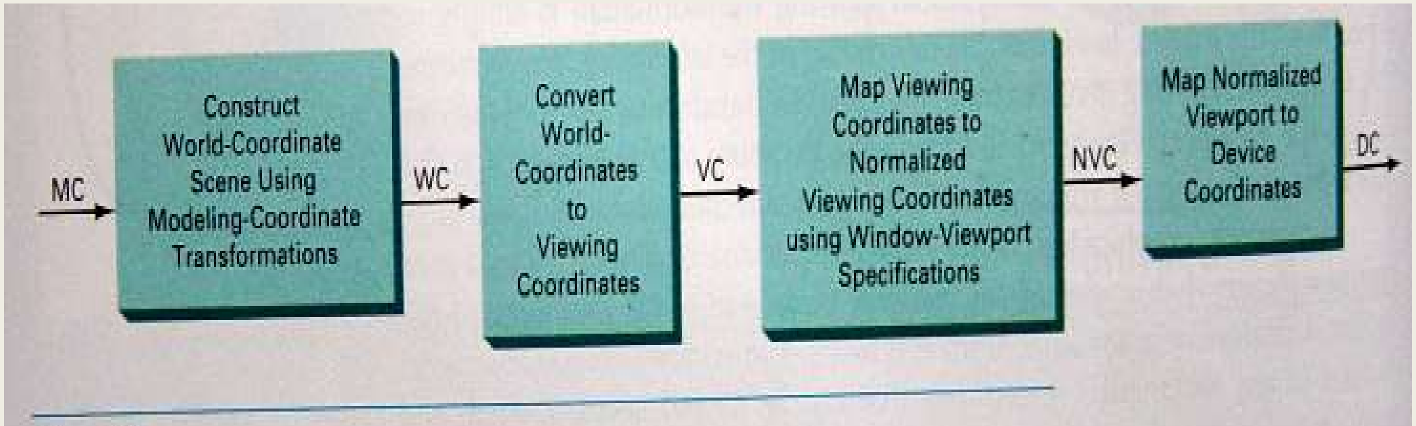


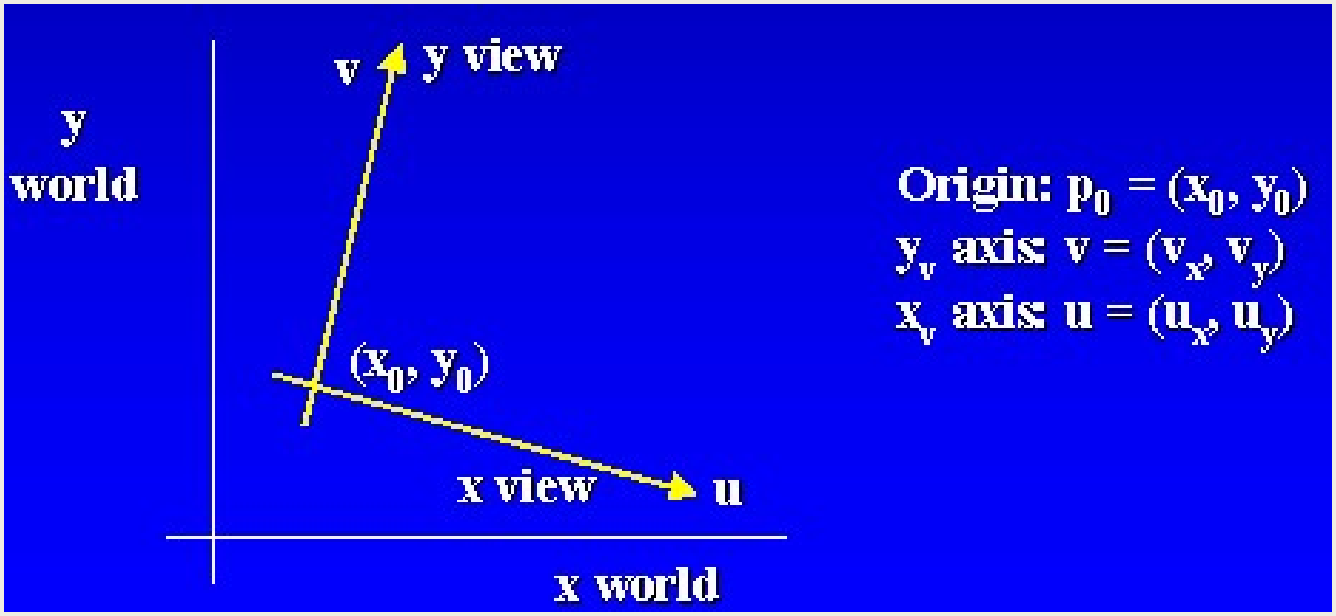
Figure 6-2
The two-dimensional viewing-transformation pipeline.

Two-Dimensional Viewing

- By changing the position of the viewport we can view objects at different positions on the display area of the output device.
- **Zooming effects**
  - *Successively mapping different-sized windows on a fixed-sized viewports.*
- **Panning effects**
  - *Moving a fixed-sized window across the various objects in a scene.*
- **Device independent**
  - *Viewports are typically defined within the unit square. (normalized coordinates)*
  - *This provides means for separating the viewing and other transformations from specific output device requirements.*

Viewing Coordinate Reference Frame

- The reference frame for specifying the world-coordinate window.
  - *Viewing-coordinate origin: P0 = (x0, y0)*
  - *Establish the orientation or rotation of this reference frame.*
  - *Specify View up vector V: Define the viewing y_v direction*

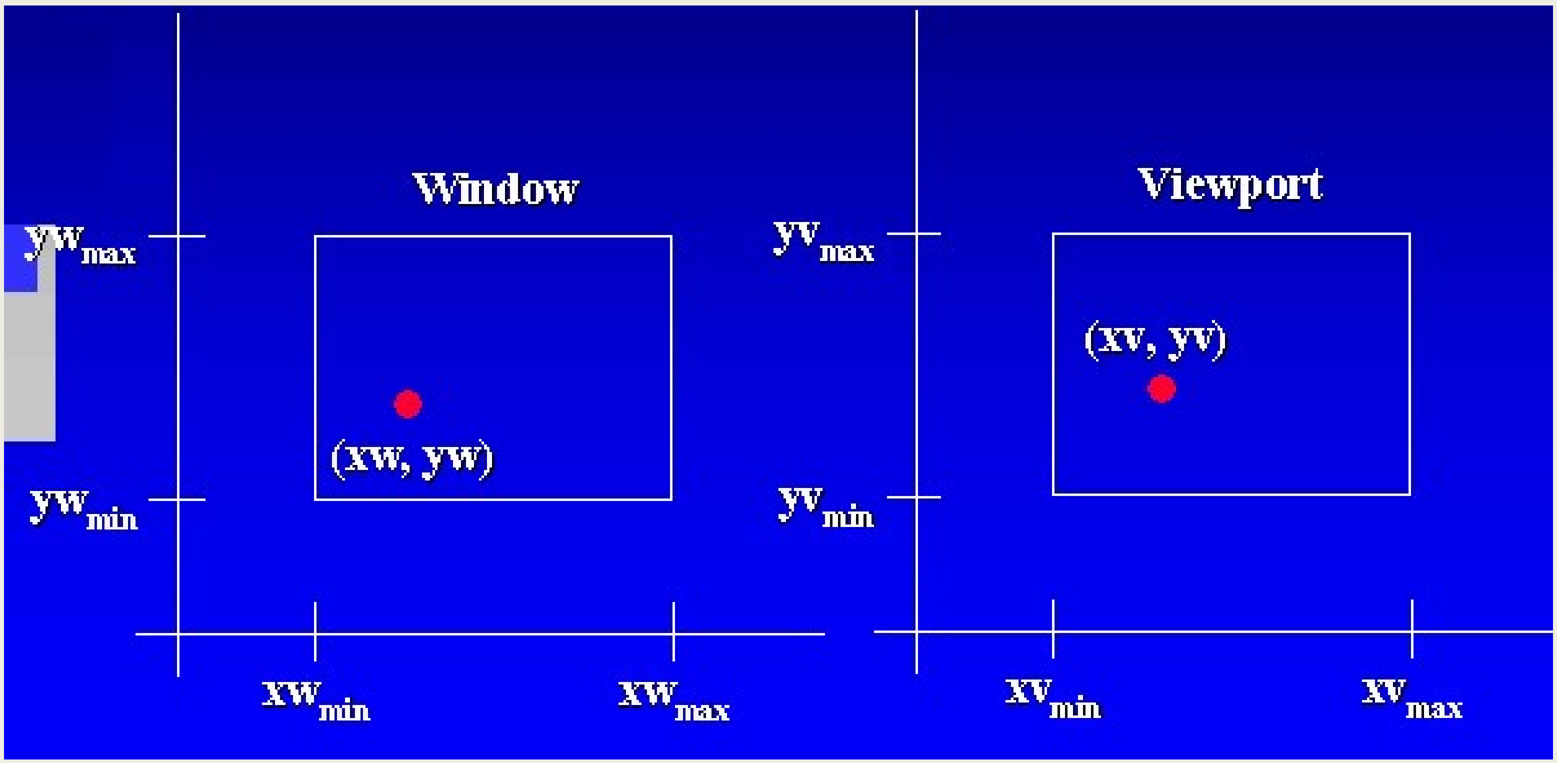


Viewing Coordinate Reference Frame

- Given V calculate the components of uint vectors v_x, v_y and u_x, u_y

  for the viewing y_v and X_v .
- These unit vectors aligns the viewing x_v, y_v axes with world axes x_w, y_w
- The composite two dimensional transformation to convert world coordinates to viewing coordinates is
- Translate the viewing origin to the world origin
- Rotate to align the two coordinate reference frames.
  - $M_{wc,vc=}R.T$

Window-to-Viewport Coordinate Transformation



Window-to-Viewport Coordinate Transformation

$$\frac{xv - xv_{\min}}{xv_{\max} - xv_{\min}} = \frac{xw - xw_{\min}}{xw_{\max} - xw_{\min}} \qquad \frac{yv - yv_{\min}}{yv_{\max} - yv_{\min}} = \frac{yw - yw_{\min}}{yw_{\max} - yw_{\min}}$$

$$xv = xv_{\min} + (xw - xw_{\min})sx$$

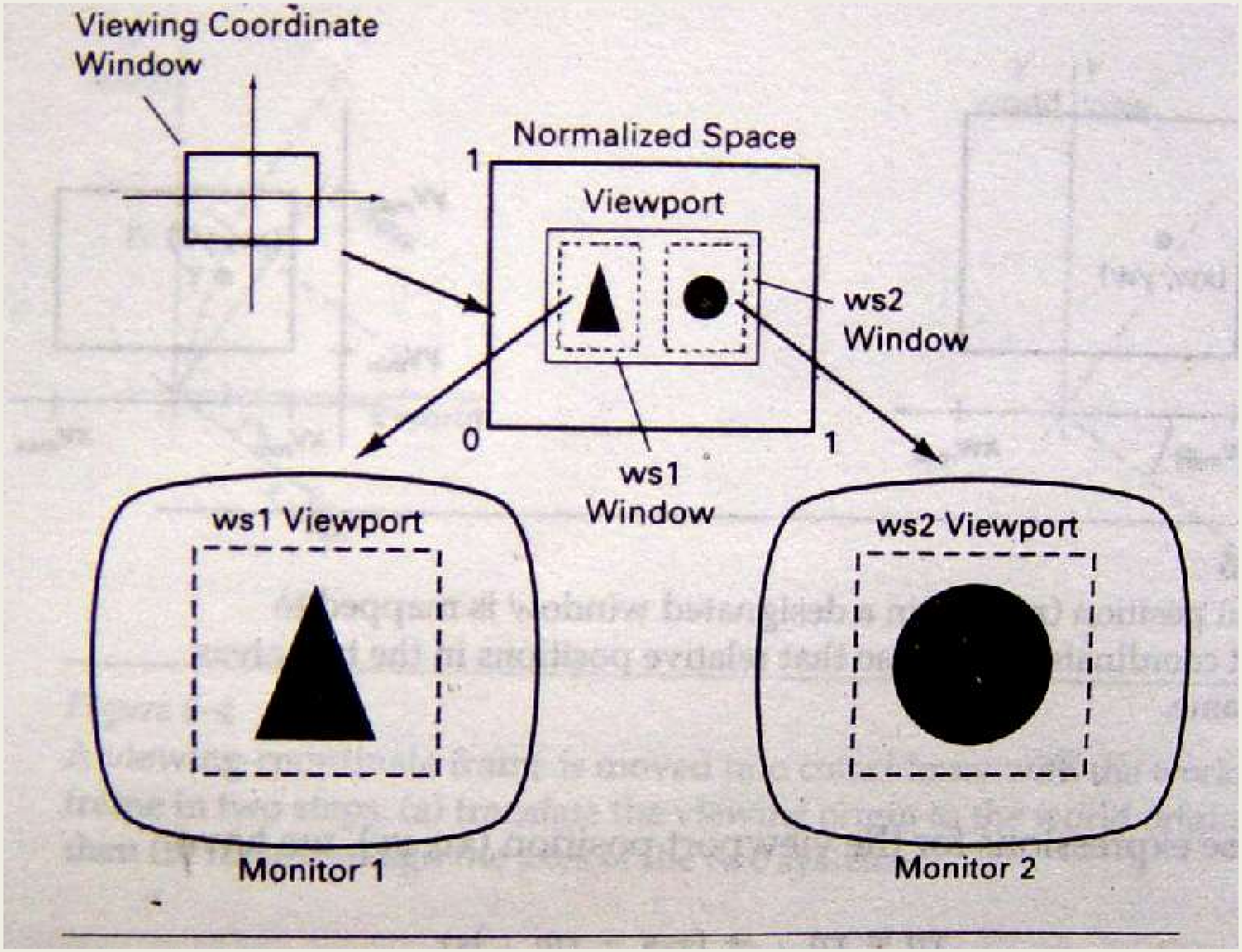
$$yv = yv_{\min} + (yw - yw_{\min})sy$$

$$sx = \frac{xv_{\max} - xv_{\min}}{xw_{\max} - xw_{\min}}$$

$$sy = \frac{yv_{\max} - yv_{\min}}{yw_{\max} - yw_{\min}}$$

A point at poisition (x_w, y_w) is mapped into position (x_v, y_v)

Workstation transformtion



Workstation Transformtion

- From normalized coordinates , object description are mapped to various display devices.
- Any no of output devices can be used and window to viewport transformation can be performed for each open output device.
- This mapping called the **workstation transformation.**
- Window area in normalized space and viewport area in the coordinates of the display device.
- Controls the positioning of parts of a scene on individual output devices.

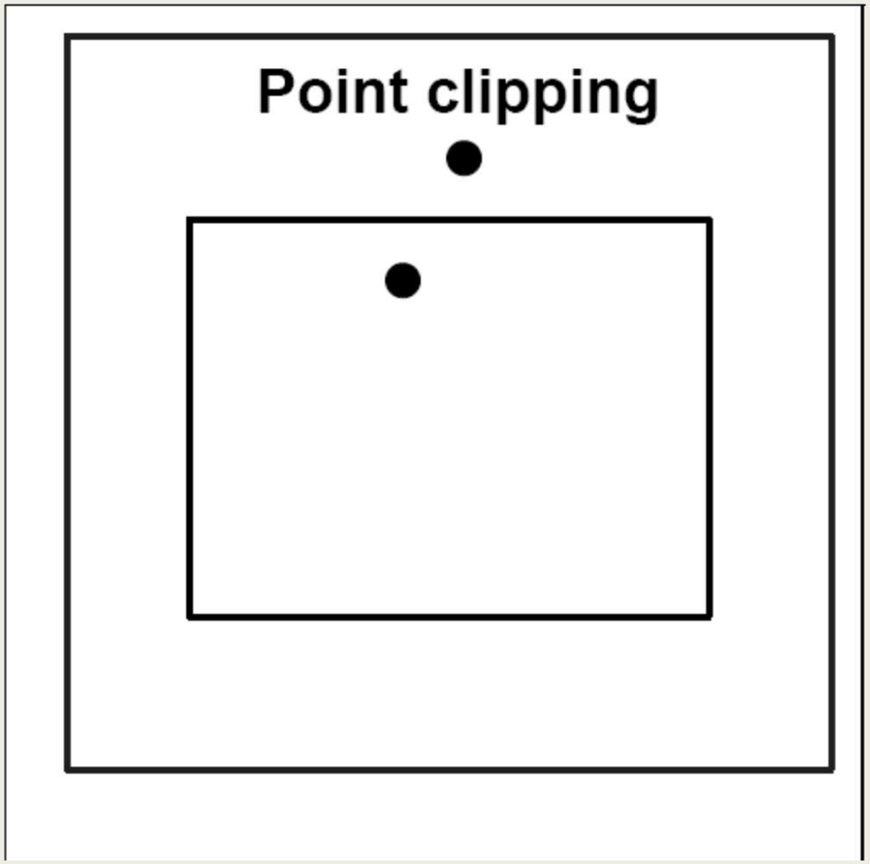
Clipping Operations

- Clipping
  - *Identify those portions of a picture that are either inside or outside of a specified region of space.*
- Clip window
  - *The region against which an object is to be clipped.*
  - *The shape of clip window*
- Applications of clipping :extracting part of the defined scene for viewing , identifying visible surfaces in 3d views etc.
- World-coordinate clipping: Clipping algorithm can be applied to the world coordinate , so the contents of the window are mapped to device coordinates.

Clipping Operations

- Viewport clipping
  - *It can reduce calculations by allowing concatenation of viewing and geometric transformation matrices.*
- Types of clipping
  - *Point clipping*
  - *Line clipping*
  - *Area (Polygon) clipping*
  - *Curve clipping*
  - *Text clipping*
- Point clipping (Rectangular clip window)

Point clipping



Point clipping

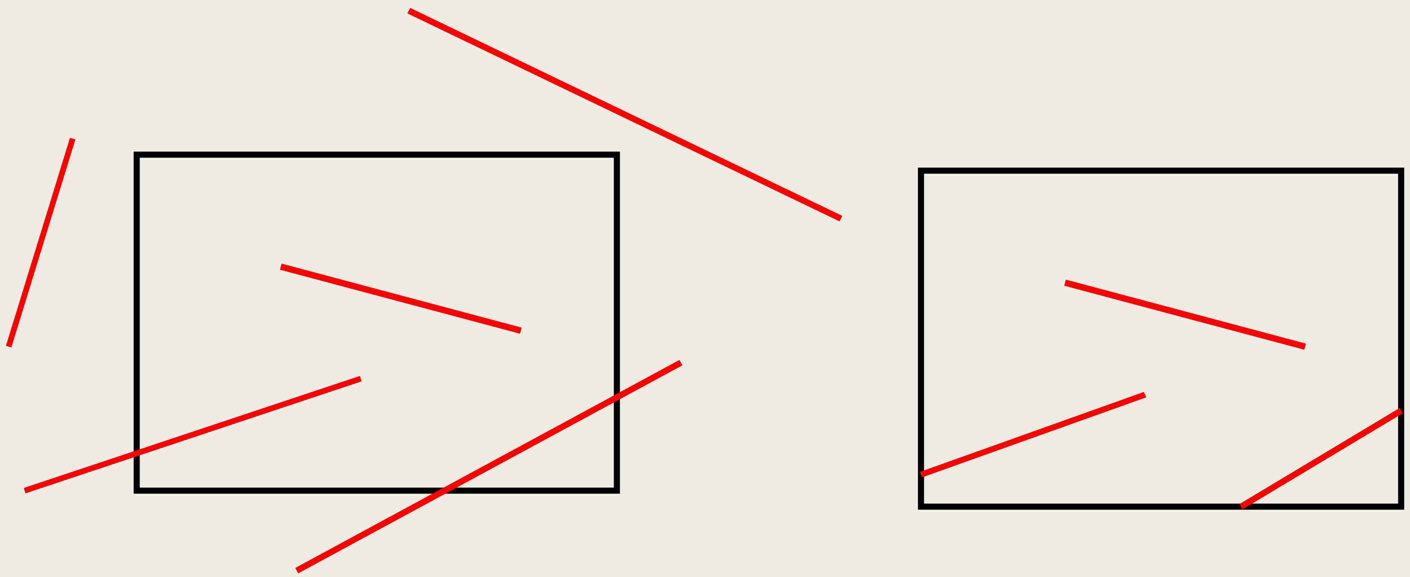
- Is point (x,y) inside the clip window?
- Considering the clip window is a rectangular window.
- A pint is inside if it satisfies the following inequalities are satisfied
  - $XW_{win} <= x <= XW_{max}$
  - $YW_{win} <=x <= YW_{max}$

where the edges of the clip window can be either world coordinate window boundaries or viewport boundaries

- If any of the inequalities are not satisfied the point is clipped.

Line Clipping

- **Possible relationships between line positions and a standard rectangular clipping region**



Before clipping after clipping

Line Clipping

- Possible relationships
  - *Completely inside the clipping window*
  - *Completely outside the window*
  - *Partially inside the window*
- Parametric representation of a line segment with endpts (x1,y1) and (x2,y2)

  $x = x_1 + u(x_2 - x_1)$

  $y = y_1 + u(y_2 - y_1)$ $0 <= u <= 1$
- The value of u for an intersection with a rectangle boundary edge
  - *Outside the range 0 to 1 ,line does not enter the interior of window*
  - *Within the range from 0 to 1,the line segment crosses the clipping area.*