Two Dimensional Viewing

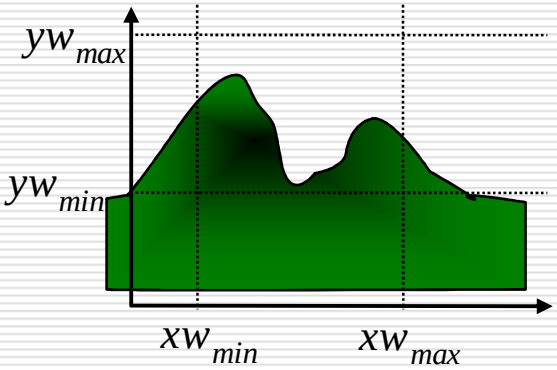
The Viewing Pipeline

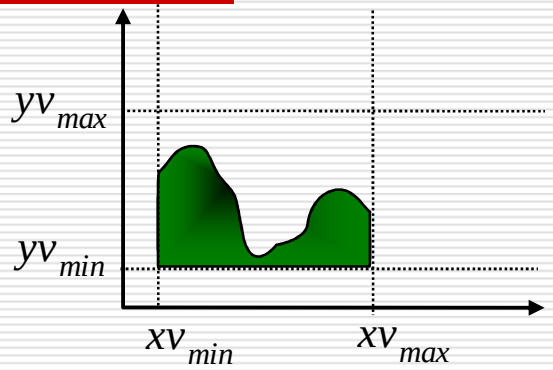
- Graphics package allows the user to specify which part of a defined picture is to be displayed and where that part is to be displayed on the display device
- **Window**
  - A world-coordinate area selected for display.

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

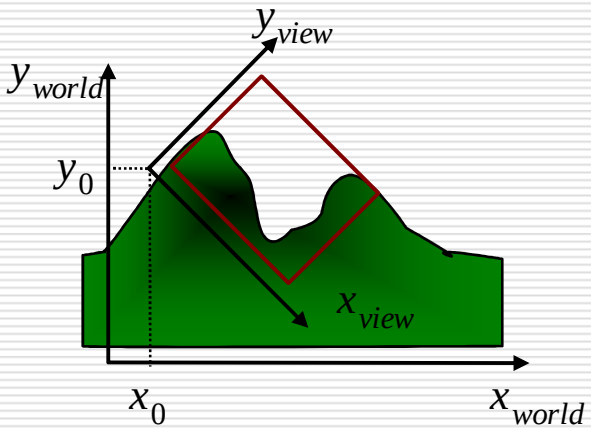
    defines *where* it is to be displayed
- **Viewing transformation**
  - The mapping of a part of a world-coordinate scene to device coordinates.
  - The two dimensional viewing transformation is referred as windowing transformations or window-to-viewport transformation.

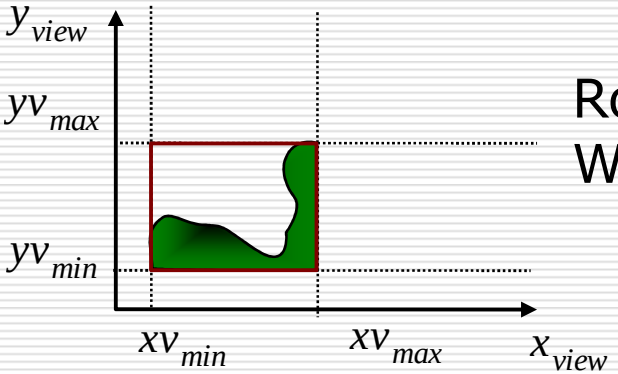
Two-Dimensional Viewing





Rectangular Window





Rotated Window

Two-Dimensional Viewing

- Rectangular rotated window viewing transformation is done using 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

The Viewing Pipeline

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

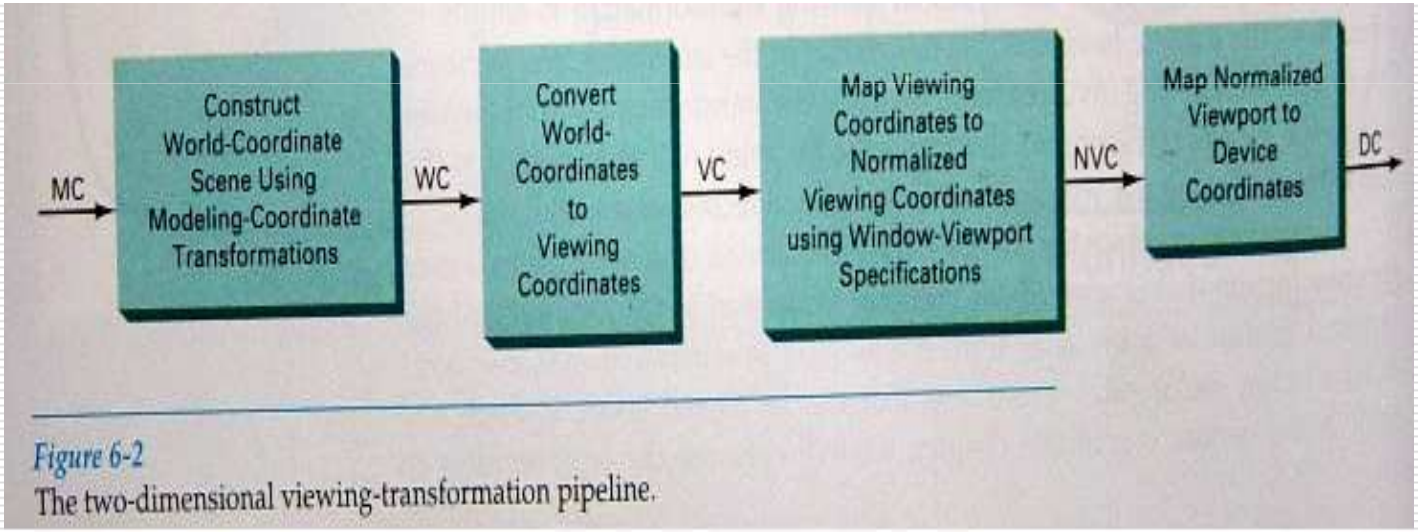


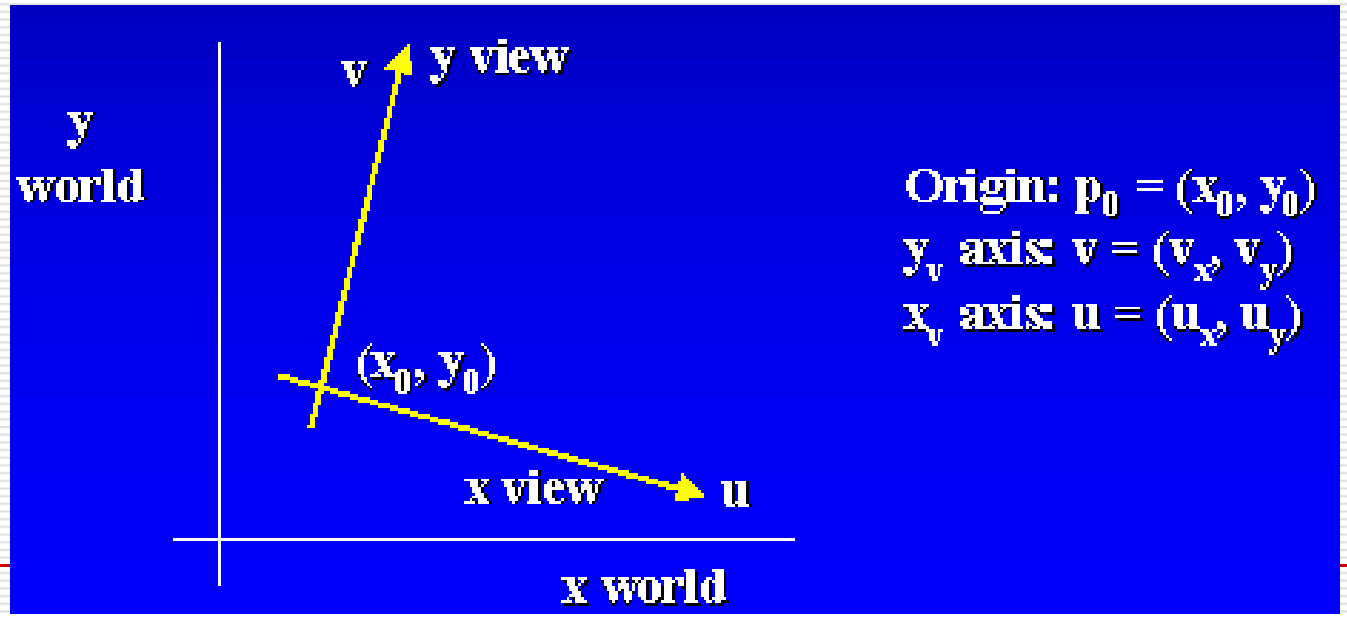
Figure 6-2
The two-dimensional viewing-transformation pipeline.

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

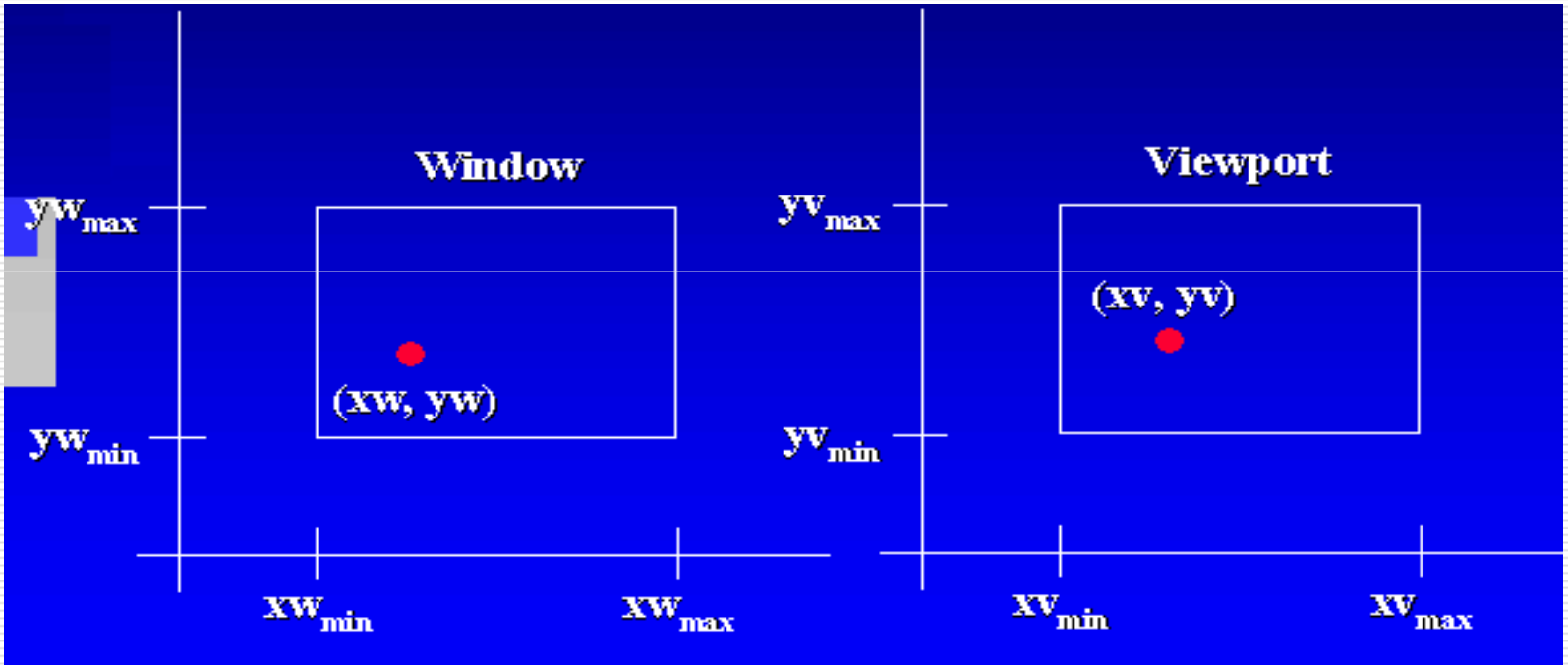


Viewing Coordinate Reference Frame

- Given V calculate the components of unit vectors v_x, v_y and u_x, u_y for the viewing reference frame 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.

$$\mathbf{M_{wc,vc}=R.T}$$

Window-to-Viewport Coordinate Transformation



Window-to-Viewport Coordinate Transformation

$$\frac{xv - xv_{\min}}{xv_{\max} - xv_{\min}} = \frac{xw - xw_{\min}}{xw_{\max} - xw_{\min}}$$

$$\frac{yv - yv_{\min}}{yv_{\max} - yv_{\min}} = \frac{yw - yw_{\min}}{yw_{\max} - yw_{\min}}$$

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

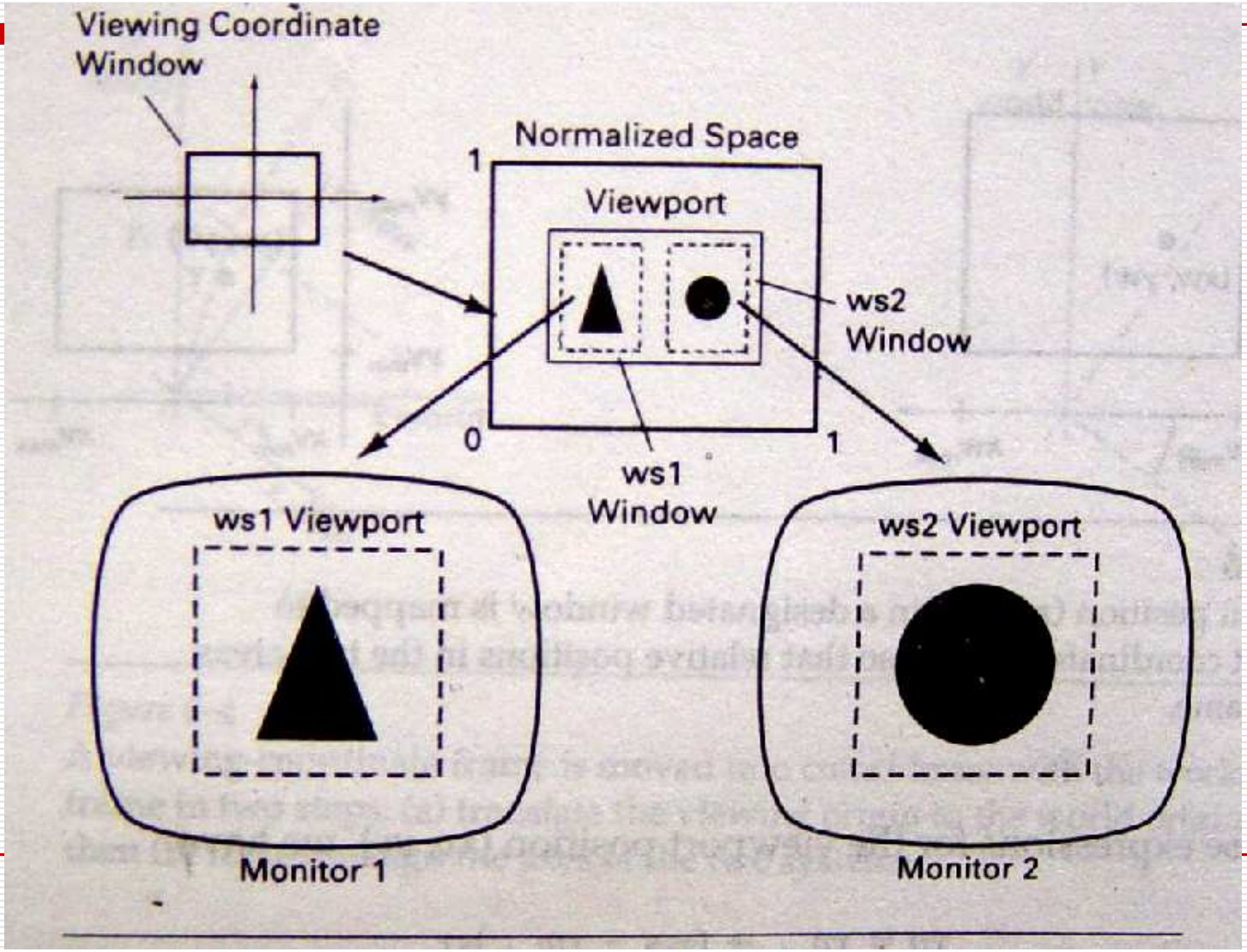
$$yv = yv_{\min} + (yw - yw_{\min})sy$$

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

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

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

Workstation transformation



Workstation Transformtion

- From normalized coordinates , object descriptions are mapped to various display devices.
- Any no. of output devices can be open in a particular application and window to viewport transformation can be performed for each open output device.
- This mapping is called the **workstation transformation.**
- We can control the positioning of parts of a scene on individual output devices.

Clipping Operations

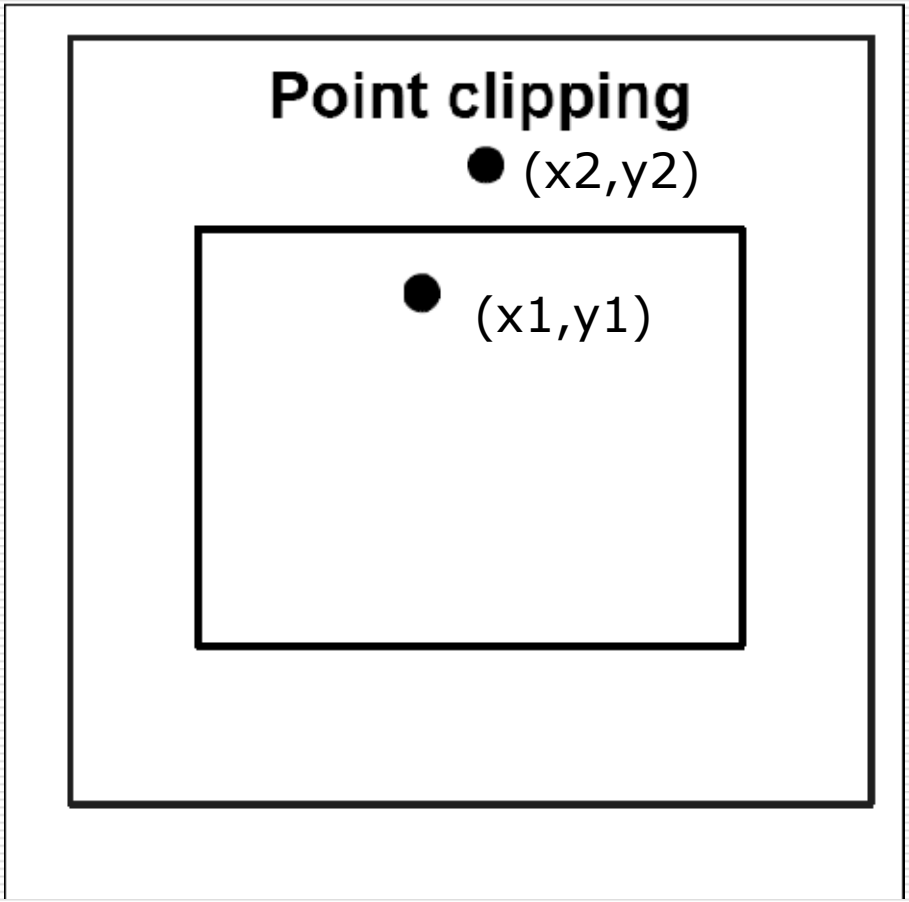
- **Clipping**
  - Identify those portions of a picture that are either inside or outside a specified region of space.
- **Clip window**
  - The region against which an object is to be clipped.
- **Applications of clipping** :extracting part of the defined scene for viewing , identifying visible surfaces 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

- **Types of clipping**

  - Point clipping
  - Line clipping
  - Area (Polygon) clipping
  - Curve clipping
  - Text clipping

Point clipping

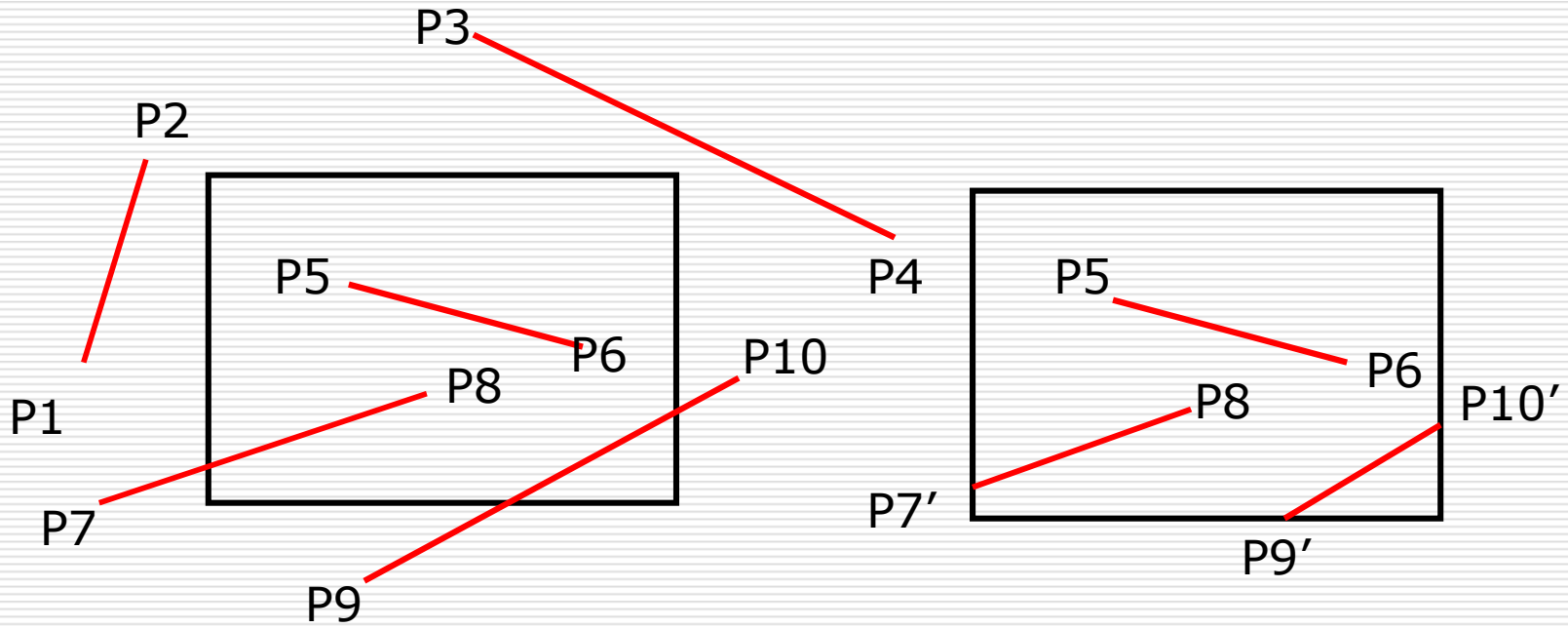


Point clipping

- Is point (x,y) inside the clip window?
- Considering the clip window is a rectangular window.
- A point is inside if it satisfies the following inequalities are satisfied
  - $XW_{min} <= x <= XW_{max}$
  - $YW_{min} <= y <= YW_{max}$
- where the edges of the clip window can be either world coordinate window boundaries or viewport boundaries
- If any of the inequalities is 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 endpoints (x1,y1) and (x2,y2)

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

$$y = y_1 + u(y_2 - y_1) \quad 0 <= u <= 1$$

can be used to determine u for intersections with clipping boundary

- 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 the window at that boundary
  - Within the range from 0 to 1,the line segment crosses the clipping area.