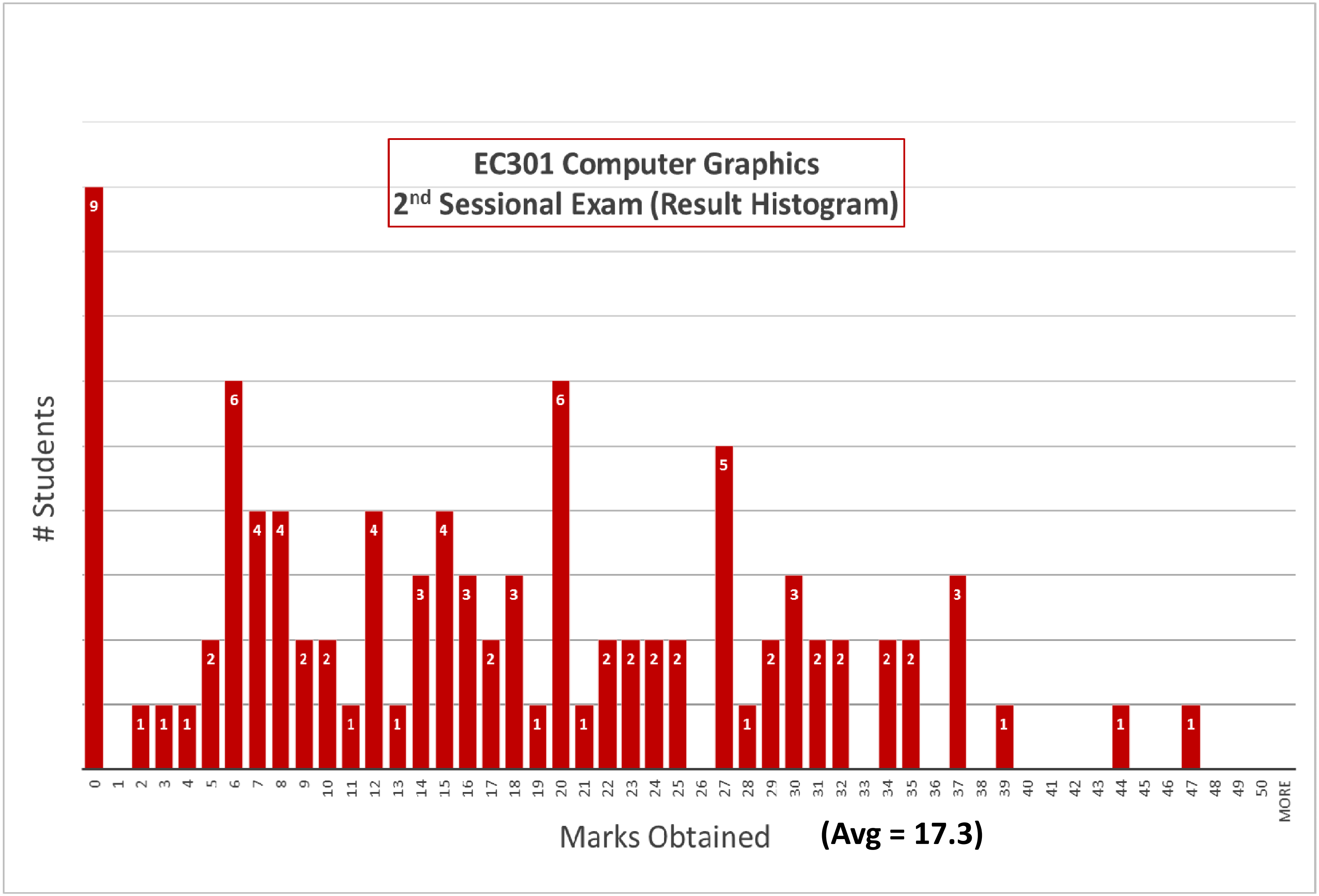
EC-301 Computer Graphics

Lecture Slides- Wk16&17:

- Revised Grading Policy
- Result Histogram- 2nd Sessional Exam
- Two-Dimensional Viewing

Revised Grading Policy

• Class Quizzes (Min 3)	6.7%
• Lab Tasks	5%
• Lab Assignmts/Quizzes	6.4%
• Project	15%
• Final Lab	6.6%
• Sessional Exam-I	13.4%
• Sessional Exam-II	13.4%
• Final Exam	33.5%


EC301 Computer Graphics
2nd Sessional Exam (Result Histogram)
Students
Marks Obtained
(Avg = 17.3)
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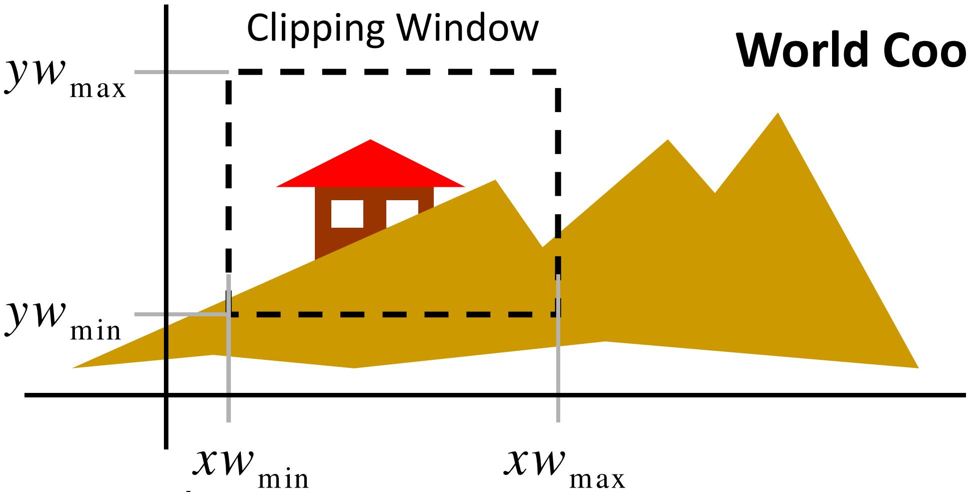
MORE

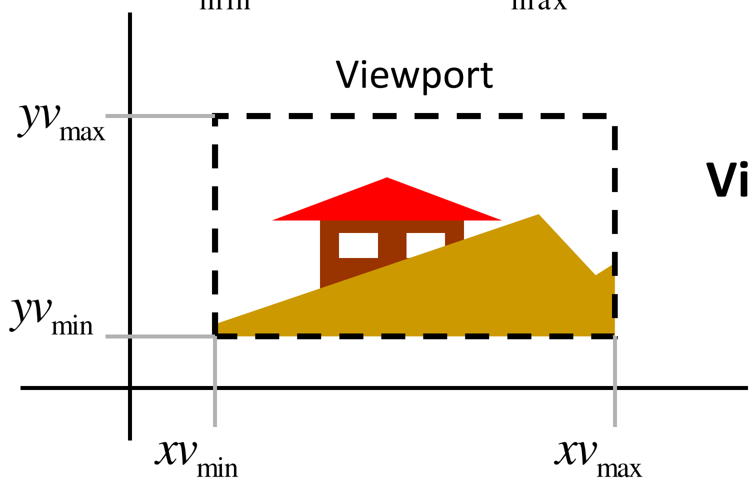
Two-Dimensional Viewing



World Coordinates

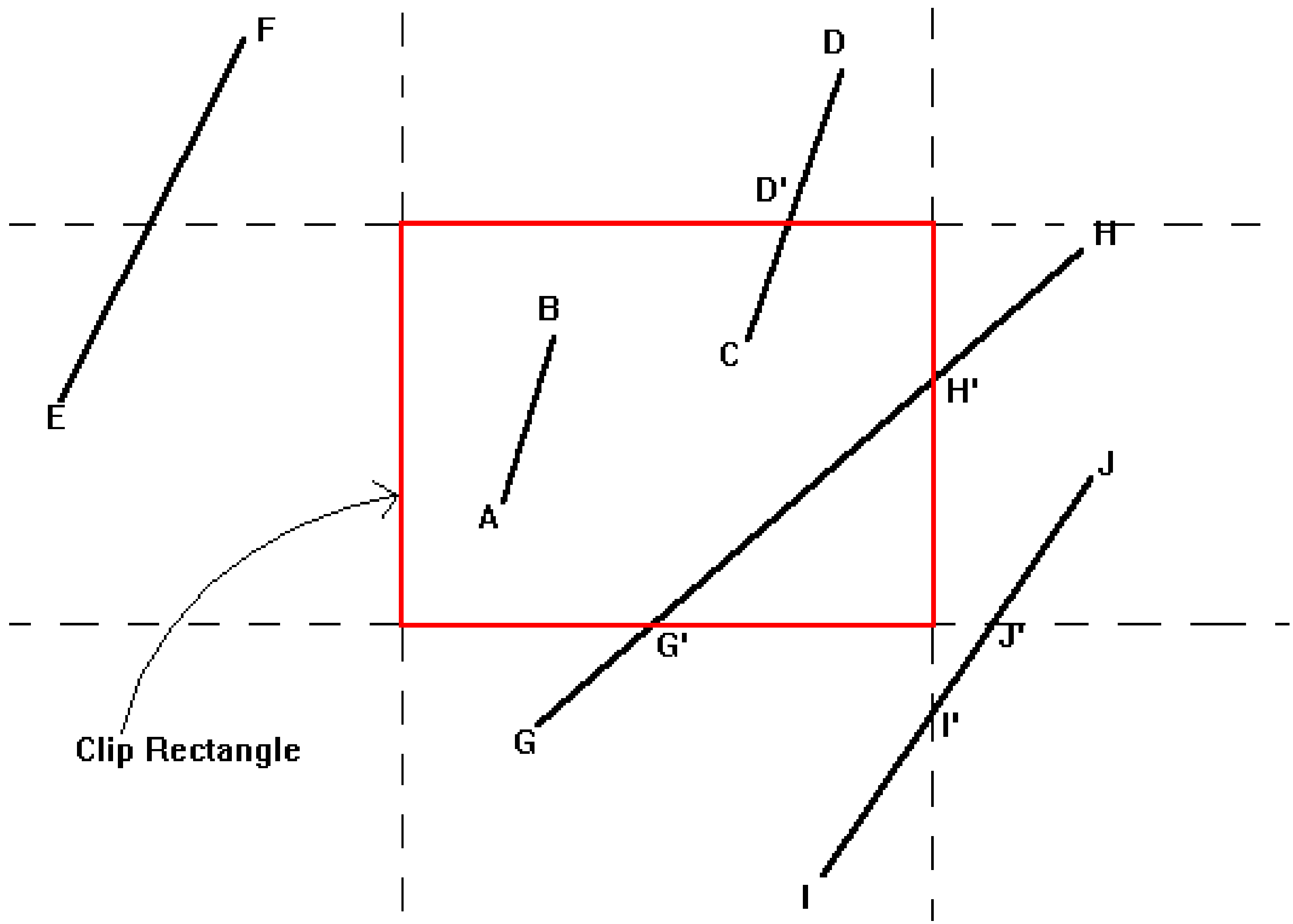
The clipping window is mapped into a viewport.

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



Viewport Coordinates

The clipping window selects what we want to see; the viewport indicates where is it to be viewed on the output device.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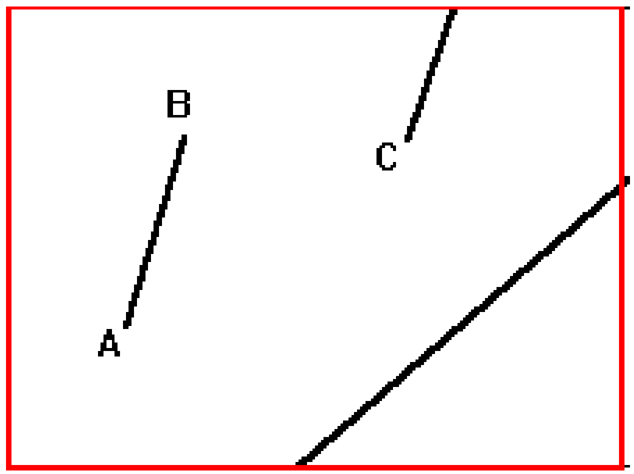
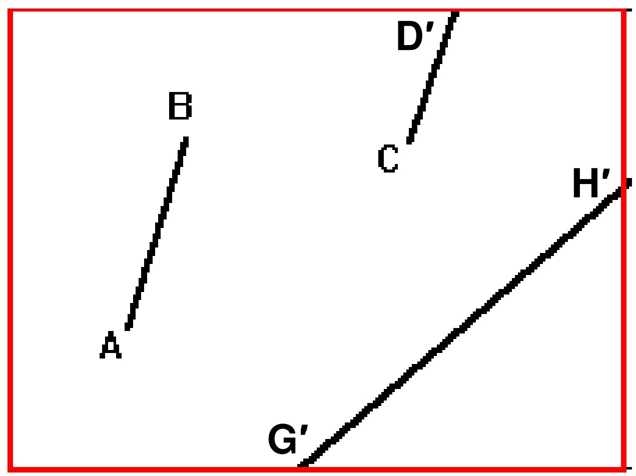
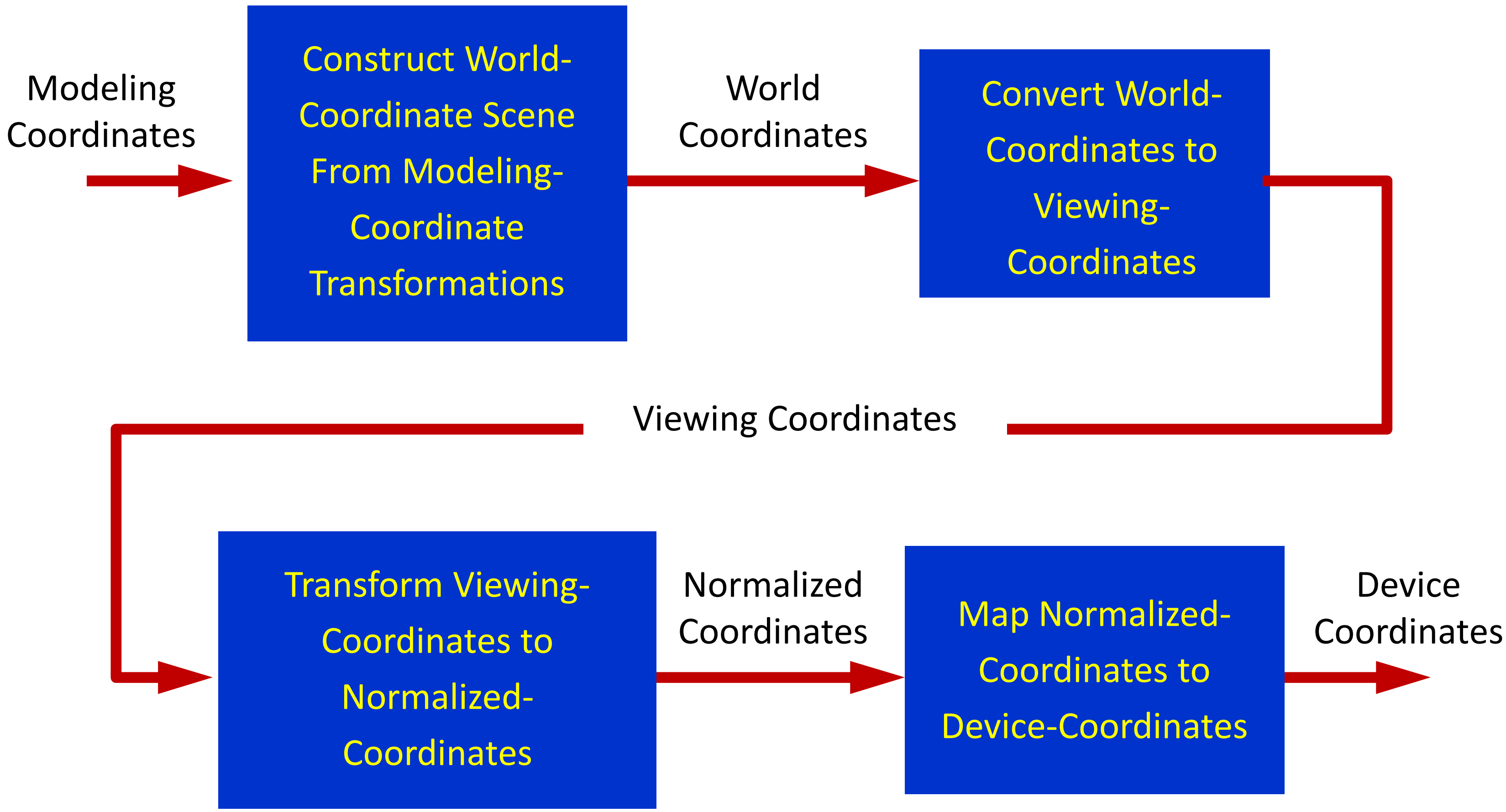
D
D'
H
B
C
H'
E
J
A
G'
J'
I'
G
Clip Rectangle
I

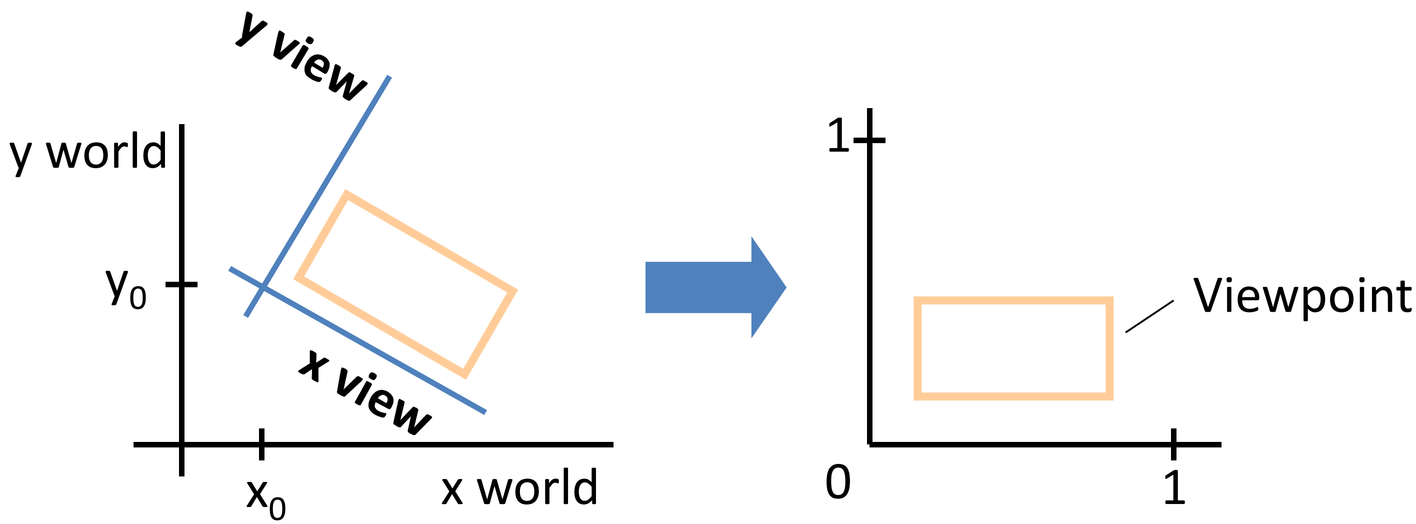

B
C
A


D′
B
C
H′
A
G′

2D Viewing Transformation Pipeline



- Setting up a rotated world window in viewing coordinates and the corresponding normalized-coordinate viewport



World Coordinates

Normalized Device Coordinates

Viewing Coordinate Reference Frame

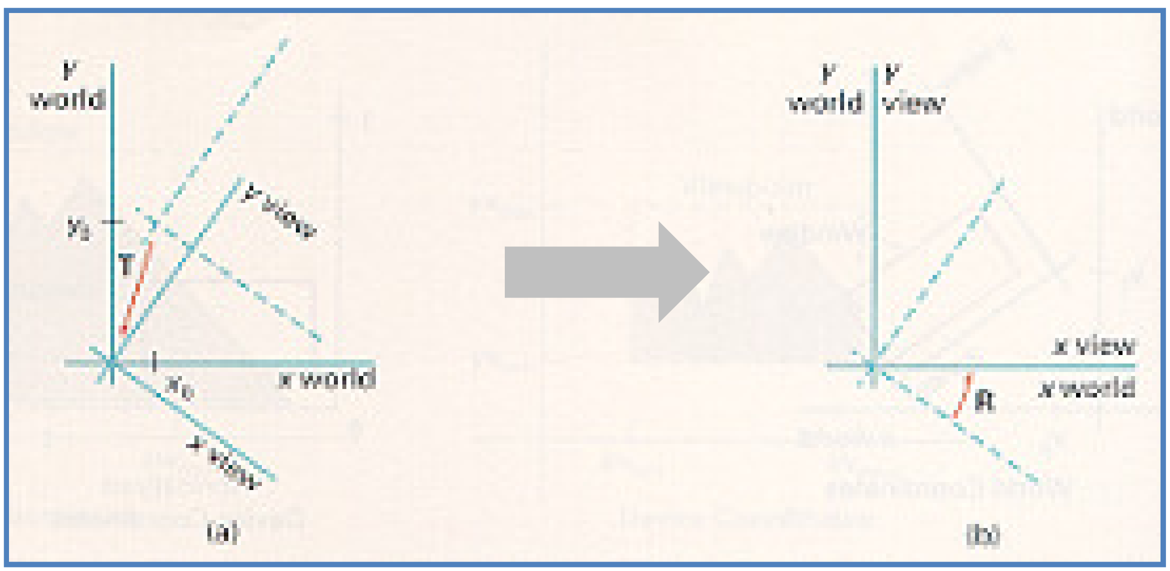
- Used to provide a method for setting up arbitrary orientations for rectangular windows
- Matrix for converting world-coordinate positions to viewing coordinate

$$\mathbf{M}_{WC,VC} = \mathbf{R} \cdot \mathbf{T}$$

R: rotation matrix
T: translation matrix

Viewing Coordinate Reference Frame

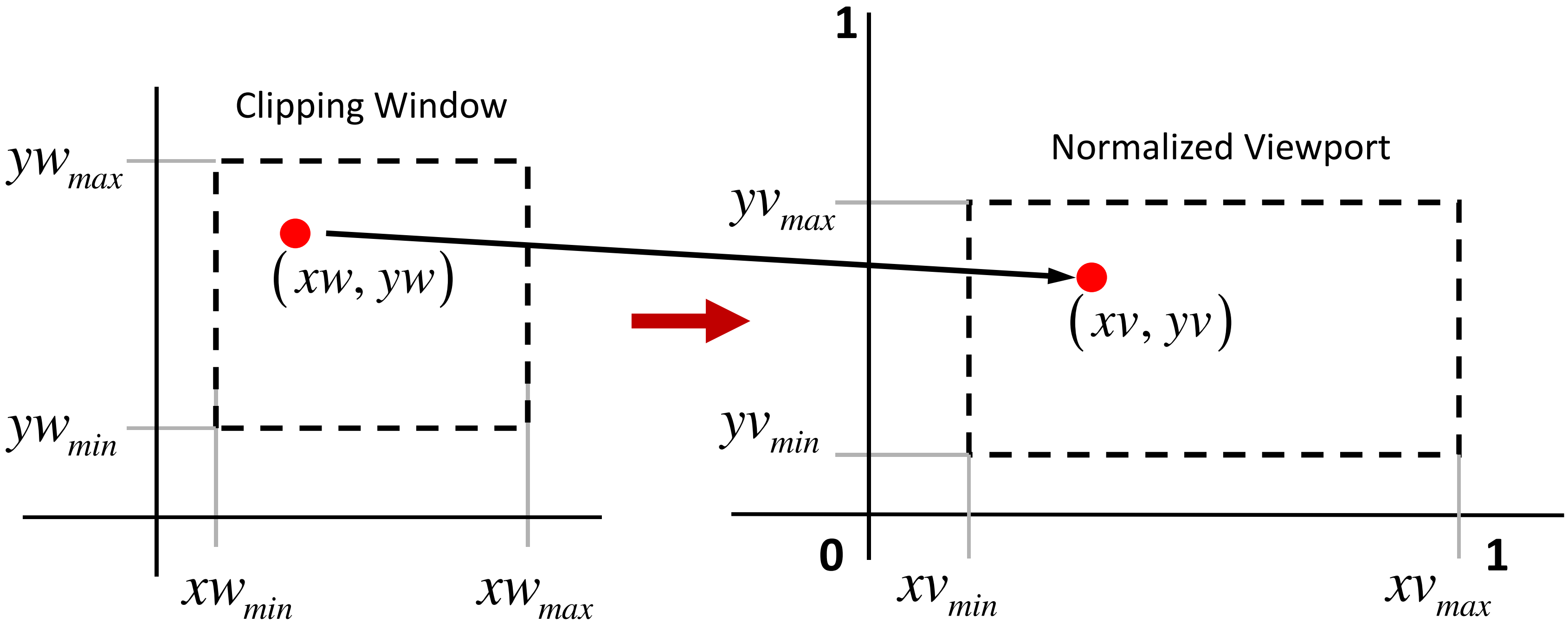
- The steps in this coordinate transformation
  - A viewing coordinate frame is moved into coincidence with the world frame in two steps
    a) Translate the viewing origin to the world origin, then
    b) Rotate to align the axes of the two systems



Normalization and Viewport Transformations

- First approach:
  - Normalization and window-to-viewport transformations are combined into one operation.
  - Viewport range can be in [0,1] x [0,1].
  - Clipping takes place in [0,1] x [0,1].
  - Viewport is then mapped to display device.
- Second approach:
  - Normalization and clipping take place before viewport transformation.
  - Viewport coordinates are specified in screen coordinates.

Mapping the Clipping Widow into a Normalized Viewport



Maintain relative size and position between clipping window and viewport.

To transform WC point into the same relative position within the viewport, we require that:

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

Solving for (xv, yv) obtains:

$$xv = s_x xw + t_x, \quad yv = s_y yw + t_y, \text{ where}$$

Scaling factors: $$s_x = \frac{xv_{\max} - xv_{\min}}{xw_{\max} - xw_{\min}}, \quad s_y = \frac{yv_{\max} - yv_{\min}}{yw_{\max} - yw_{\min}}$$

Translation factors:

$$t_x = \frac{xw_{\max} xv_{\min} - xw_{\min} xv_{\max}}{xw_{\max} - xw_{\min}}, \quad t_y = \frac{yw_{\max} yv_{\min} - yw_{\min} yv_{\max}}{yw_{\max} - yw_{\min}}$$

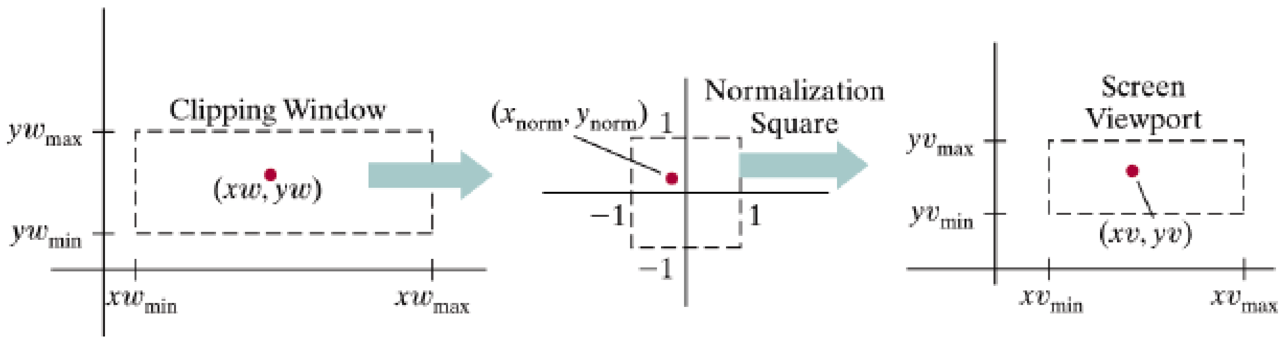
Composite matrix representation for the transformation to the normalized viewport:

$$\mathbf{M}_{\substack{\text{window,}\\ \text{norm\_viewport}}} = \begin{bmatrix} s_x & 0 & t_x \\ 0 & s_y & t_y \\ 0 & 0 & 1 \end{bmatrix}$$

- Conversion sequence of transformation:
  1. Perform a scaling transformation using a fixed-point position of (xw_{min}, yw_{min}) that scales the window area to the size of the viewport
  1. Translate the scaled window area to the position of the viewport

$$\mathbf{M}_{\substack{\text{window,}\\ \text{norm\_viewport}}} = \begin{bmatrix} s_x & 0 & t_x \\ 0 & s_y & t_y \\ 0 & 0 & 1 \end{bmatrix}$$

Mapping the Clipping Widow into a Normalized Square



$$\mathbf{M}_{\substack{window,\\ norm\_square}} = \begin{bmatrix} \frac{2}{xw_{max} - xw_{min}} & 0 & -\frac{xw_{max} + xw_{min}}{xw_{max} - xw_{min}} \\ 0 & \frac{2}{yw_{max} - yw_{min}} & -\frac{yw_{max} + yw_{min}}{yw_{max} - yw_{min}} \\ 0 & 0 & 1 \end{bmatrix}$$

$$\mathbf{M}_{\substack{norm\_square,\\ viewport}} = \begin{bmatrix} (xv_{max} - xv_{min})/2 & 0 & (xv_{max} + xv_{min})/2 \\ 0 & (yv_{max} - yv_{min})/2 & (yv_{max} + yv_{min})/2 \\ 0 & 0 & 1 \end{bmatrix}$$