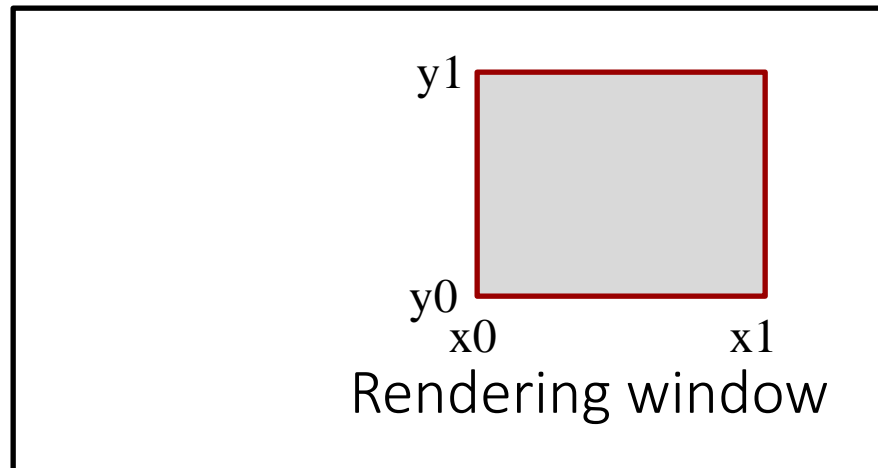


Today

- Rendering pipeline
- Projections
- View volumes
- Viewport transformation

Viewport transformation

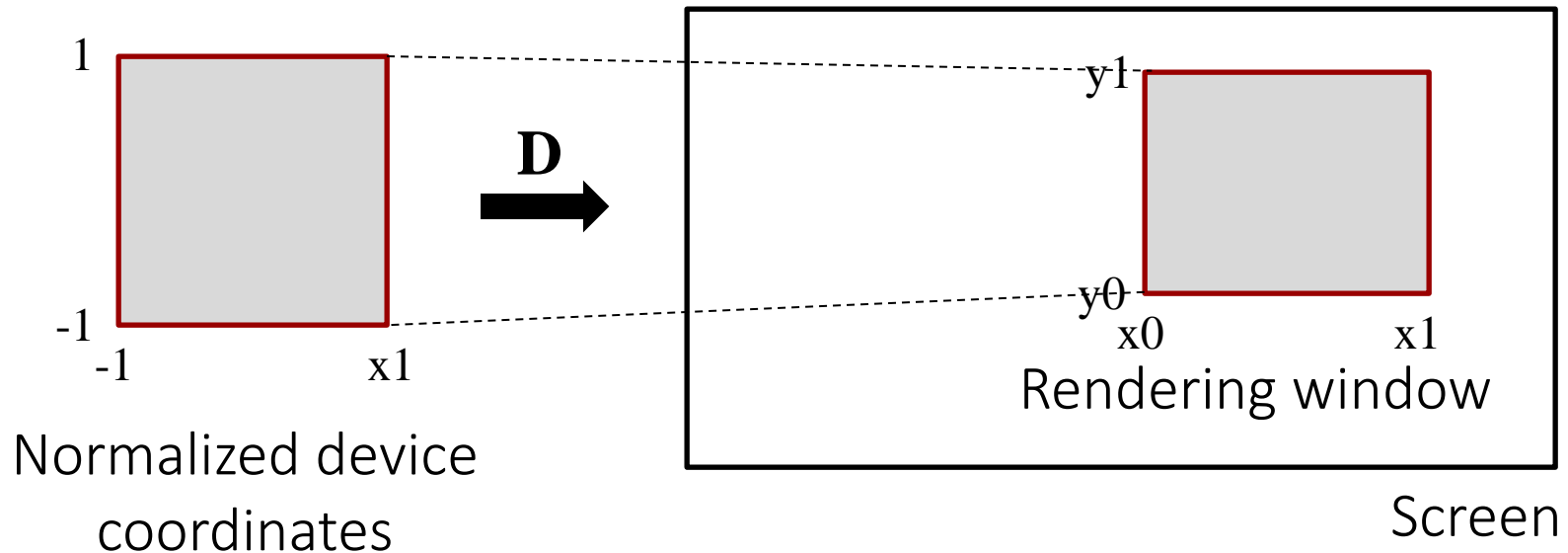
- After applying projection matrix, image points are in **normalized view coordinates**
 - Per definition range $[-1..1] \times [-1..1]$
- Map points to image (i.e., pixel) coordinates
 - User defined range $[x0...x1] \times [y0...y1]$
 - E.g., position of rendering window on screen



Viewport transformation

- Scale and translation

$$\mathbf{D}(x_0, x_1, y_0, y_1) = \begin{bmatrix} (x_1 - x_0)/2 & 0 & 0 & (x_0 + x_1)/2 \\ 0 & (y_1 - y_0)/2 & 0 & (y_0 + y_1)/2 \\ 0 & 0 & 1/2 & 1/2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$



The complete transform

- Mapping a 3D point in object coordinates to pixel coordinates
- Object-to-world matrix **M**, camera matrix **C**, projection matrix **C**, viewport matrix **D**

$$p' = \mathbf{DPC}^{-1}\mathbf{M}p$$

Object space