CS130 : Computer Graphics

Lecture 9: Viewing Transformations (cont.)

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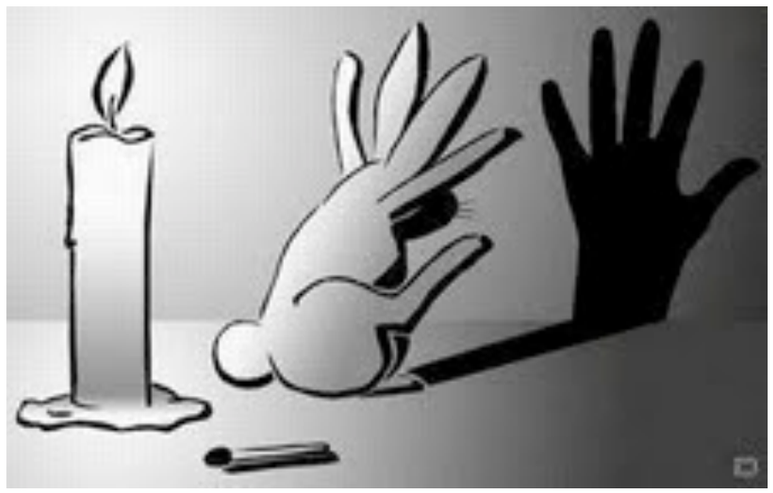
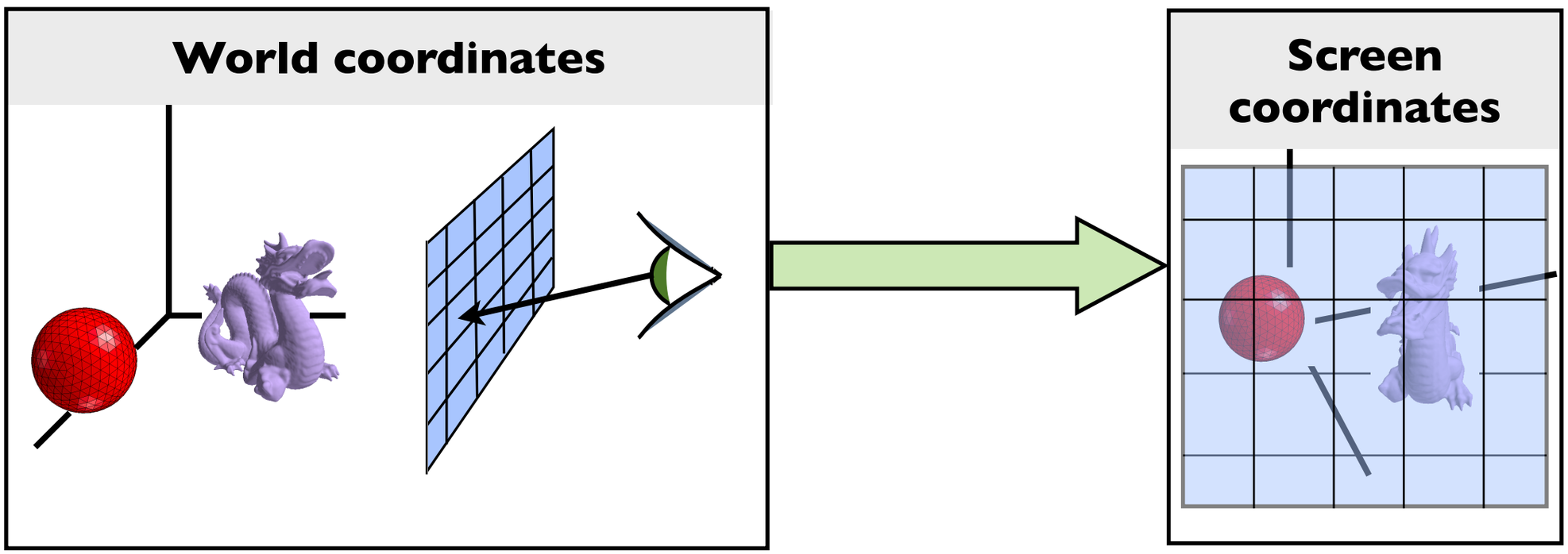
Viewing Transformations



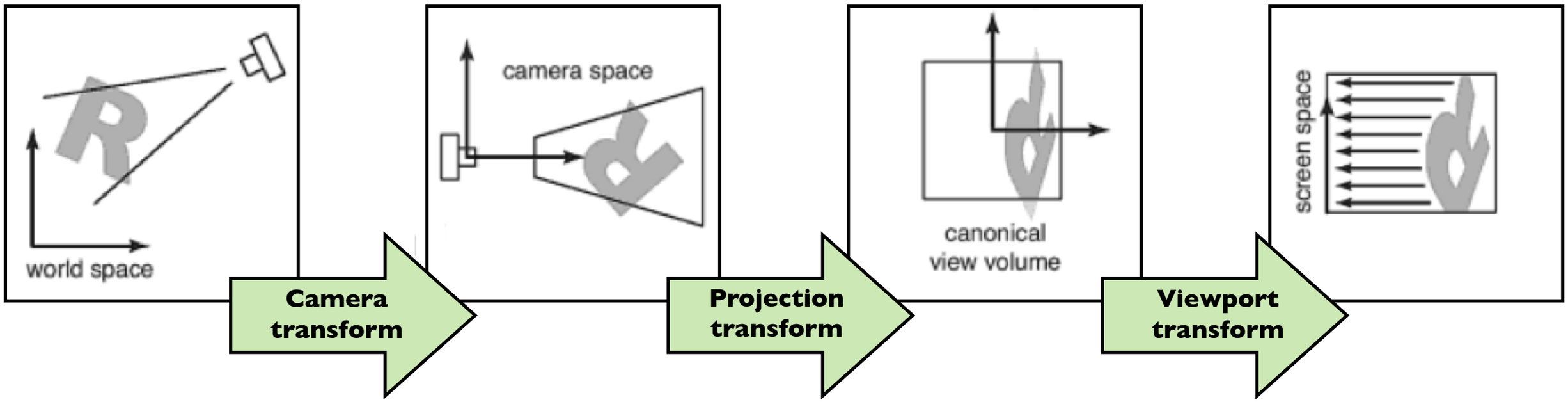
Viewing transformations

- Move objects from their 3D locations to their positions in a 2D view



The viewing transformation also projects any point along the pixel's view ray back to the pixel's position in **image space**

Decomposition of viewing transforms



- rigid body transformation
- place camera at origin

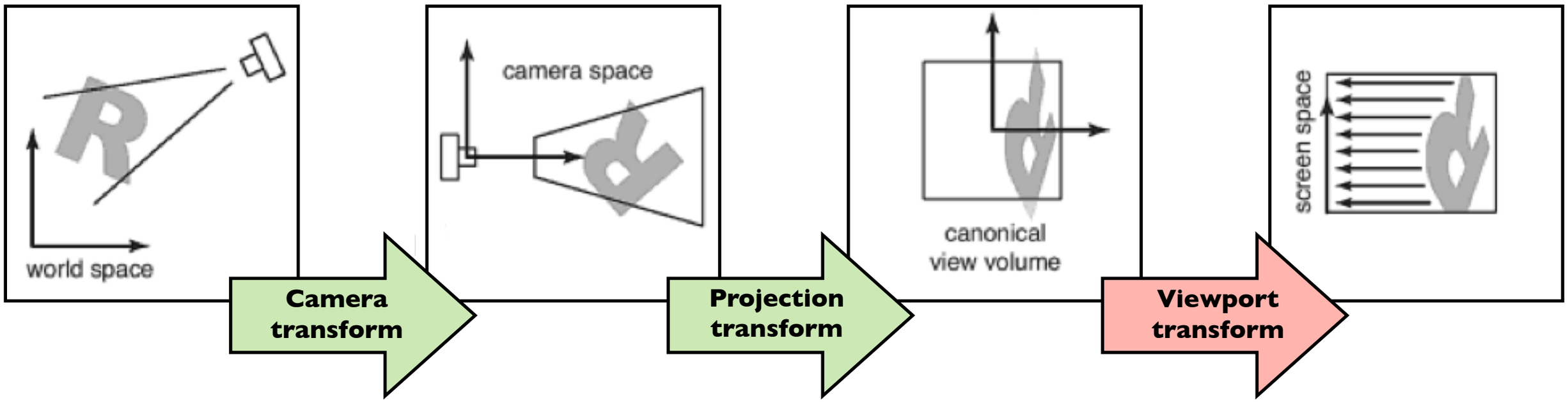
- x, y, z in [-1,1]
- depends on type of projection

- map to pixel coordinates

Viewing transforms depend on: camera position and orientation, type of projection, field of view, image resolution

there are several names for these spaces: “camera space” = “eye space”, “canonical view volume” = “clip space”= “normalized device coordinates”, “screen space=pixel coordinates” and for the transforms: “camera transformation” = “viewing transformation”

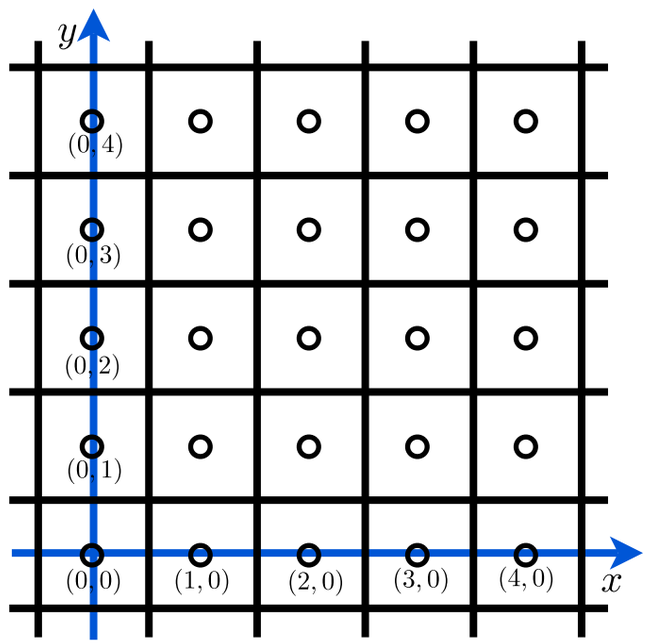
Viewport transform



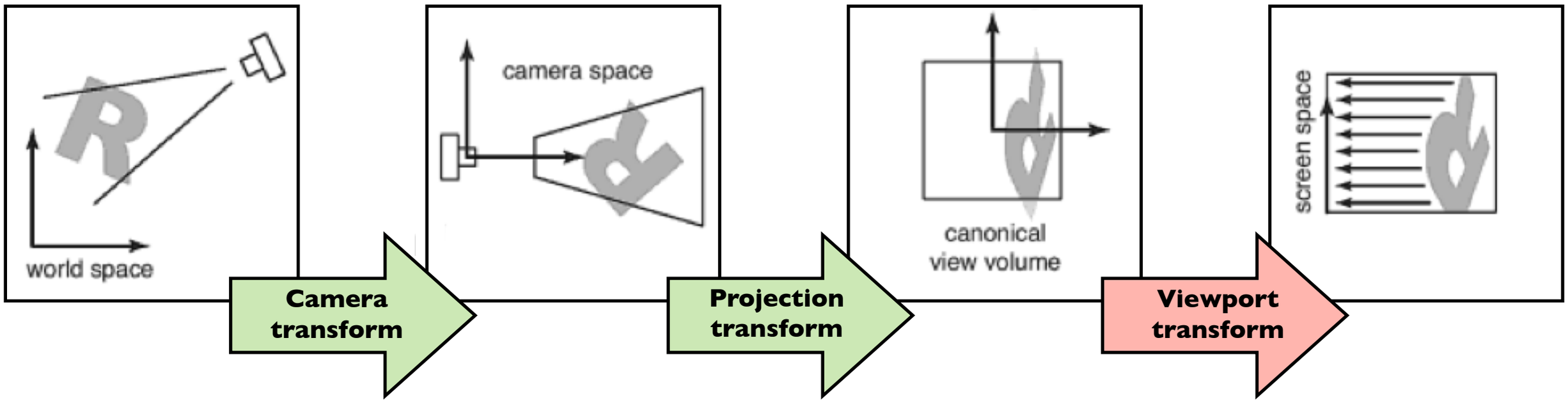
$$(x, y, z) \rightarrow (x', y', z')$$

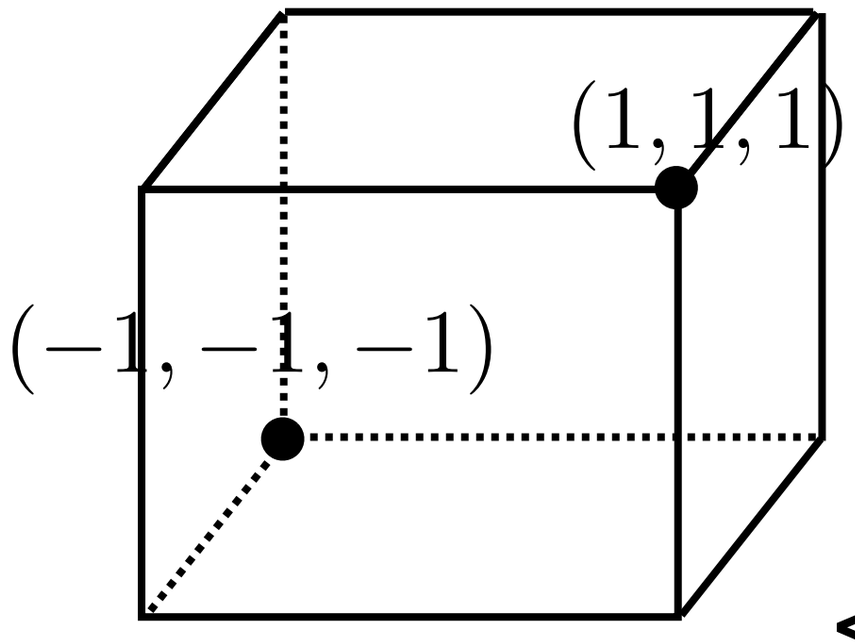
$$(x, y, z) \in [-1, 1]^3$$

$$x' \in [-.5, n_x - .5]$$
$$y' \in [-.5, n_y - .5]$$



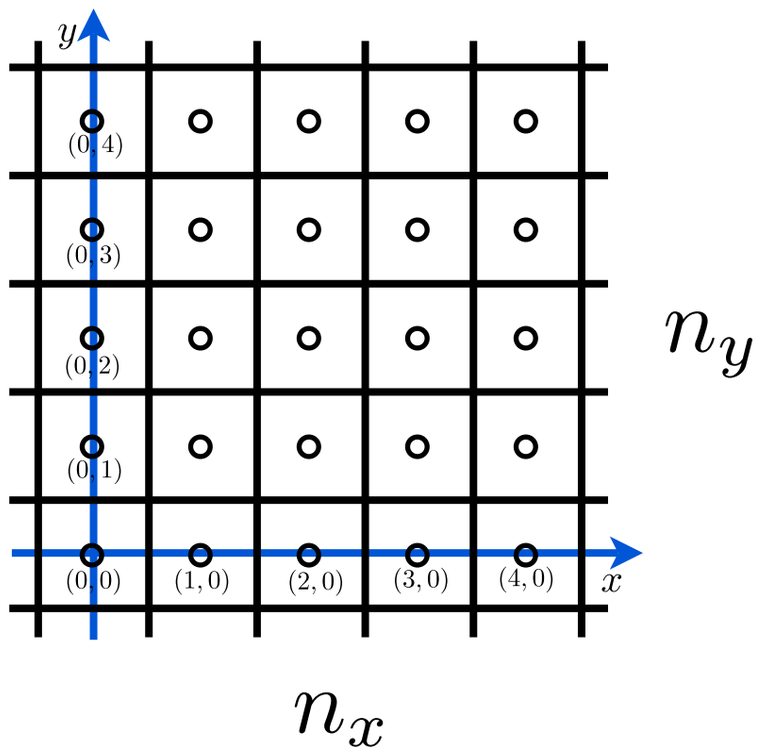
Viewport transform





M_{vp}

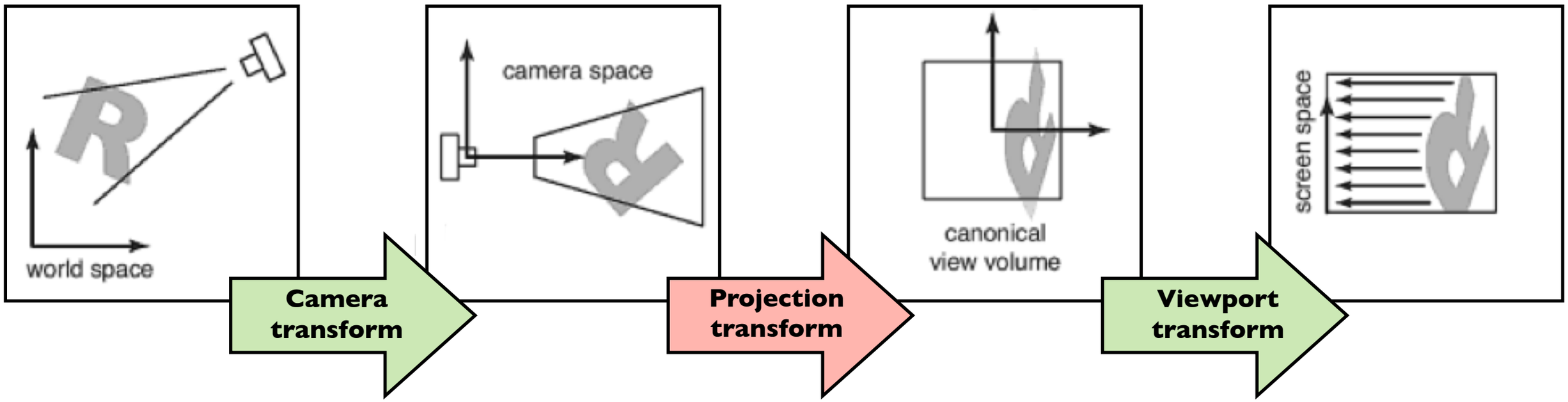
<whiteboard>

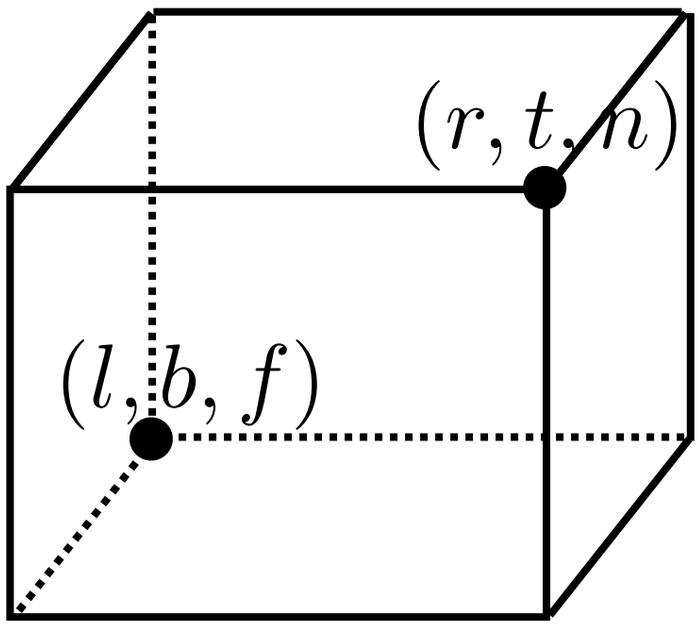


n_y

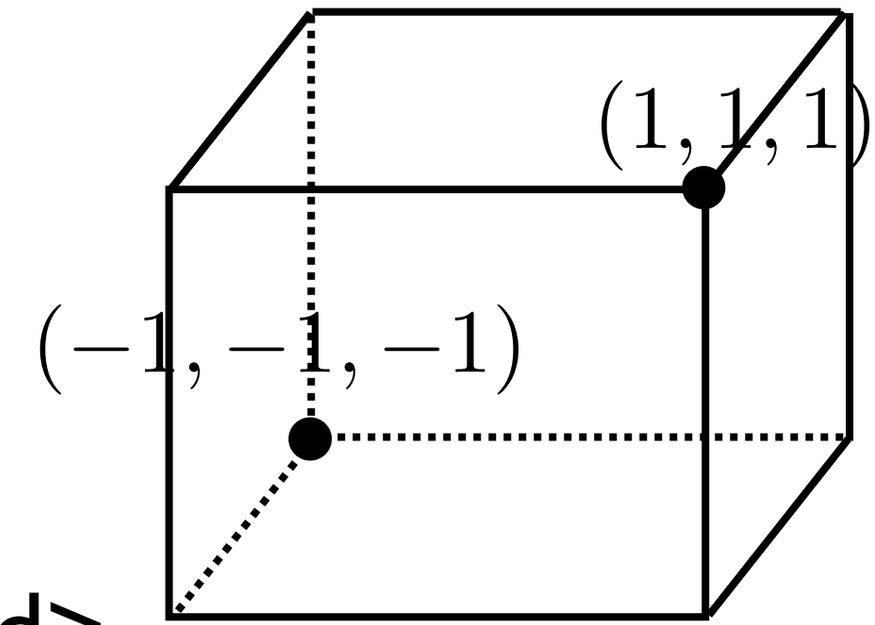
n_x

Orthographic Projection Transform



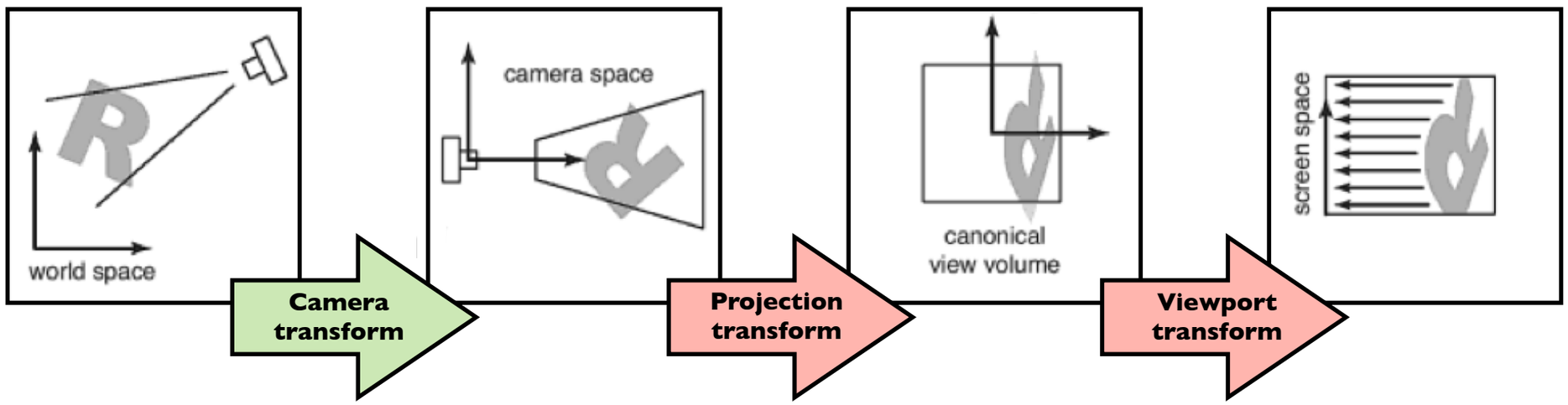


M_{orth}



<whiteboard>

Line drawing algorithm



construct M_{vp}

construct M_{orth}

$M = M_{vp} M_{orth}$

for each line segment (a_i, b_i) do

$\mathbf{p} = M\mathbf{a}_i$

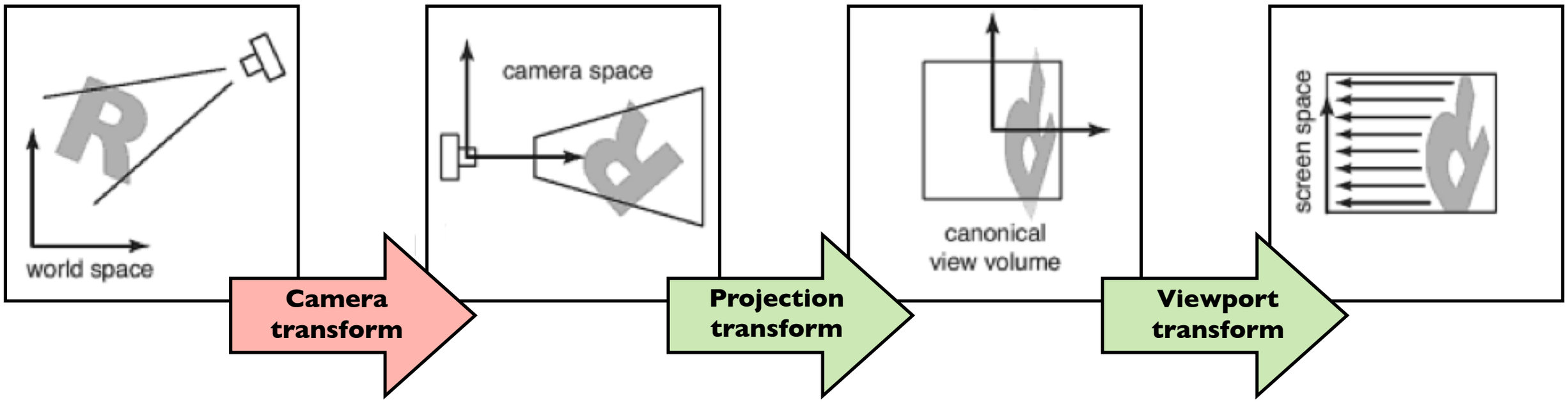
$\mathbf{q} = M\mathbf{b}_i$

drawline (x_p, y_p, x_q, y_q)

draw lines specified in <u>camera</u> space

Shirley, Marschner 7.1

Camera Transform



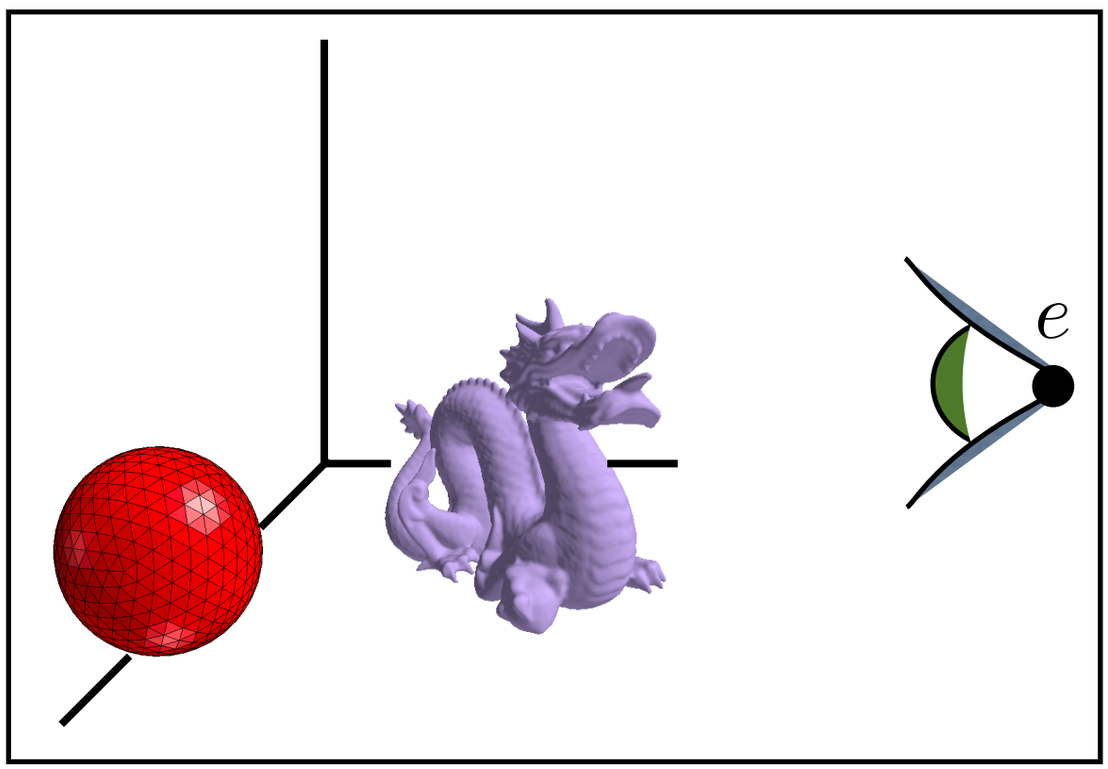
Camera Transform

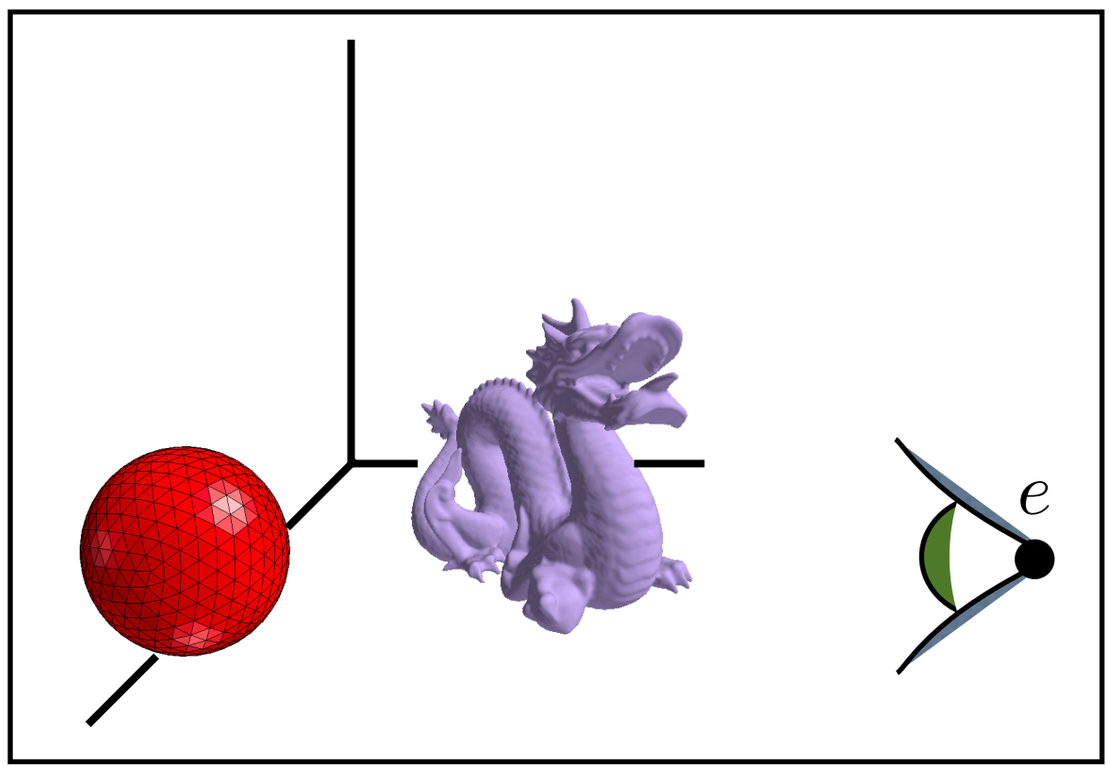
How do we specify the camera configuration?

(orthogonal case)

Camera Transform

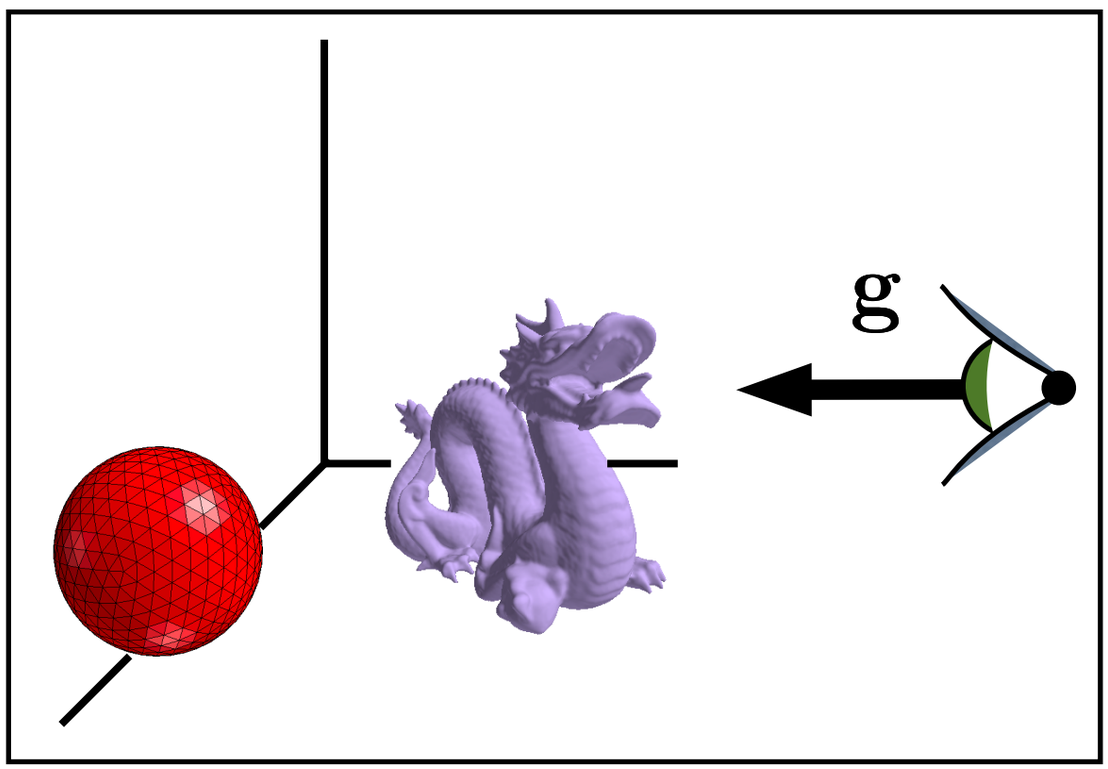
How do we specify the camera configuration? **eye position**

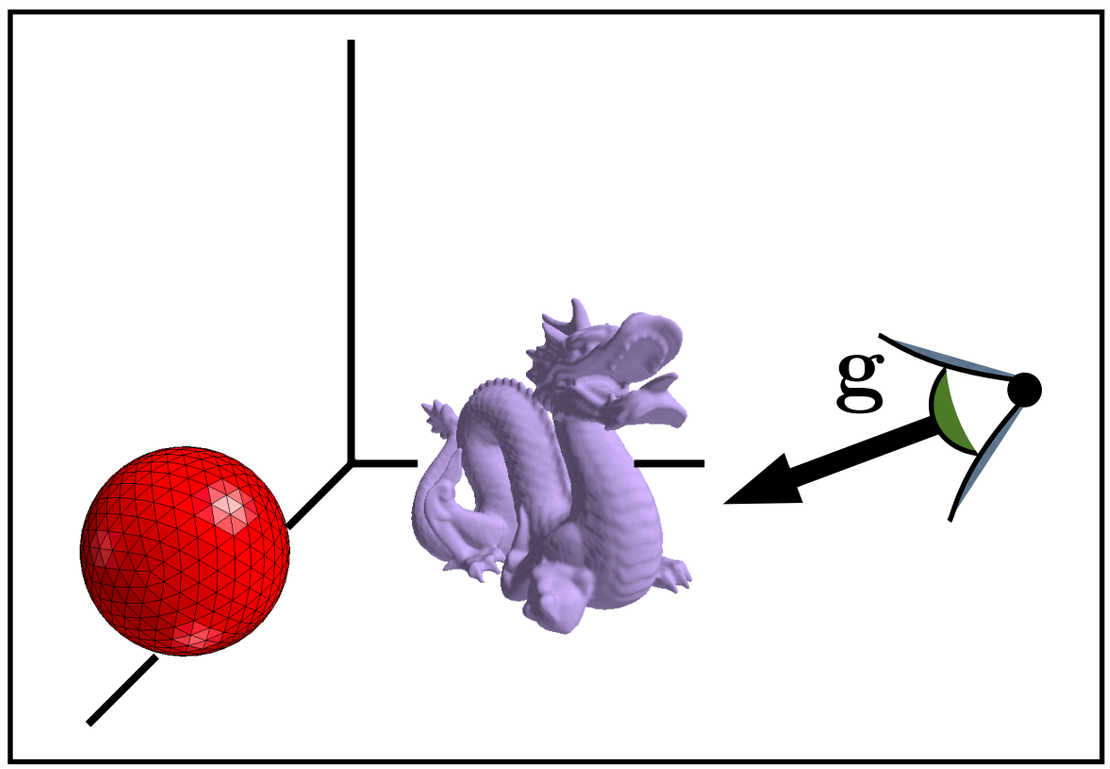




Camera Transform

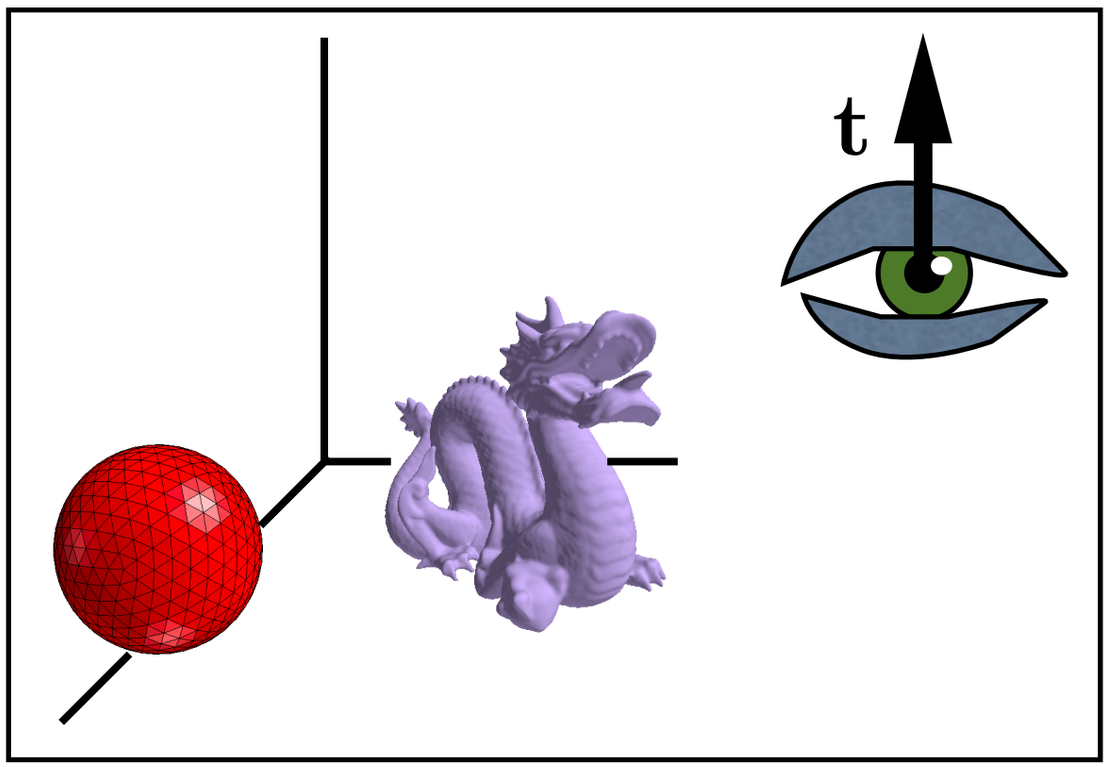
How do we specify the camera configuration? **gaze direction**

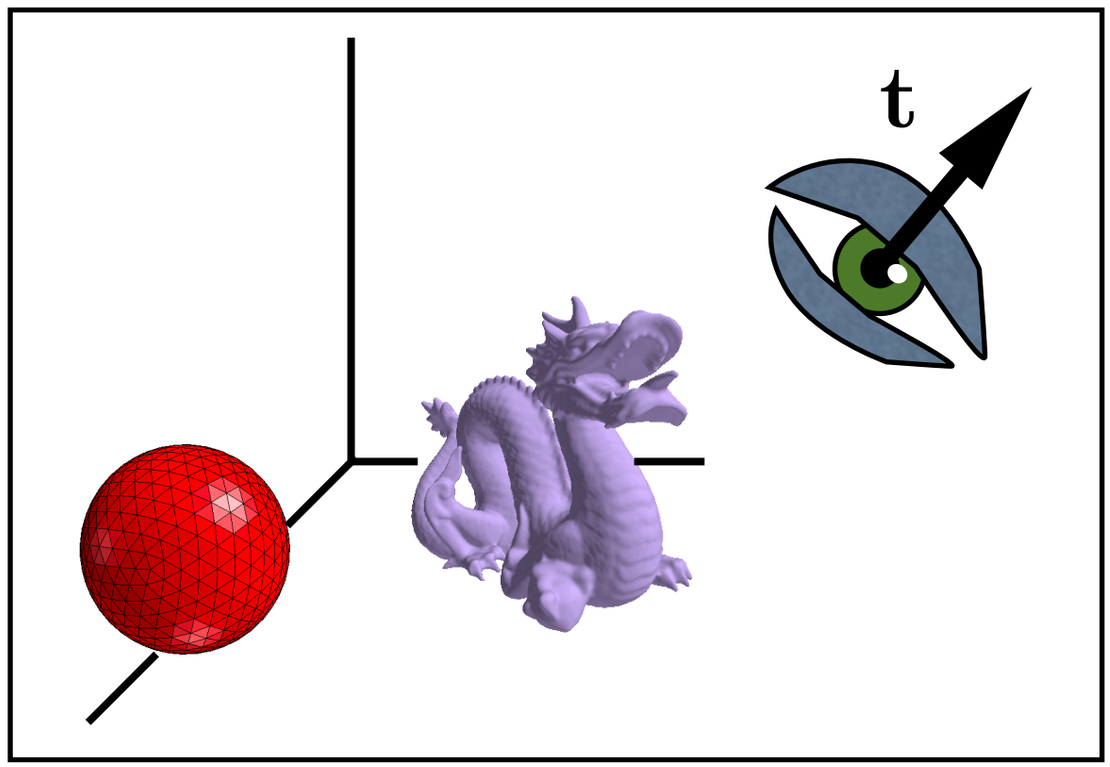




Camera Transform

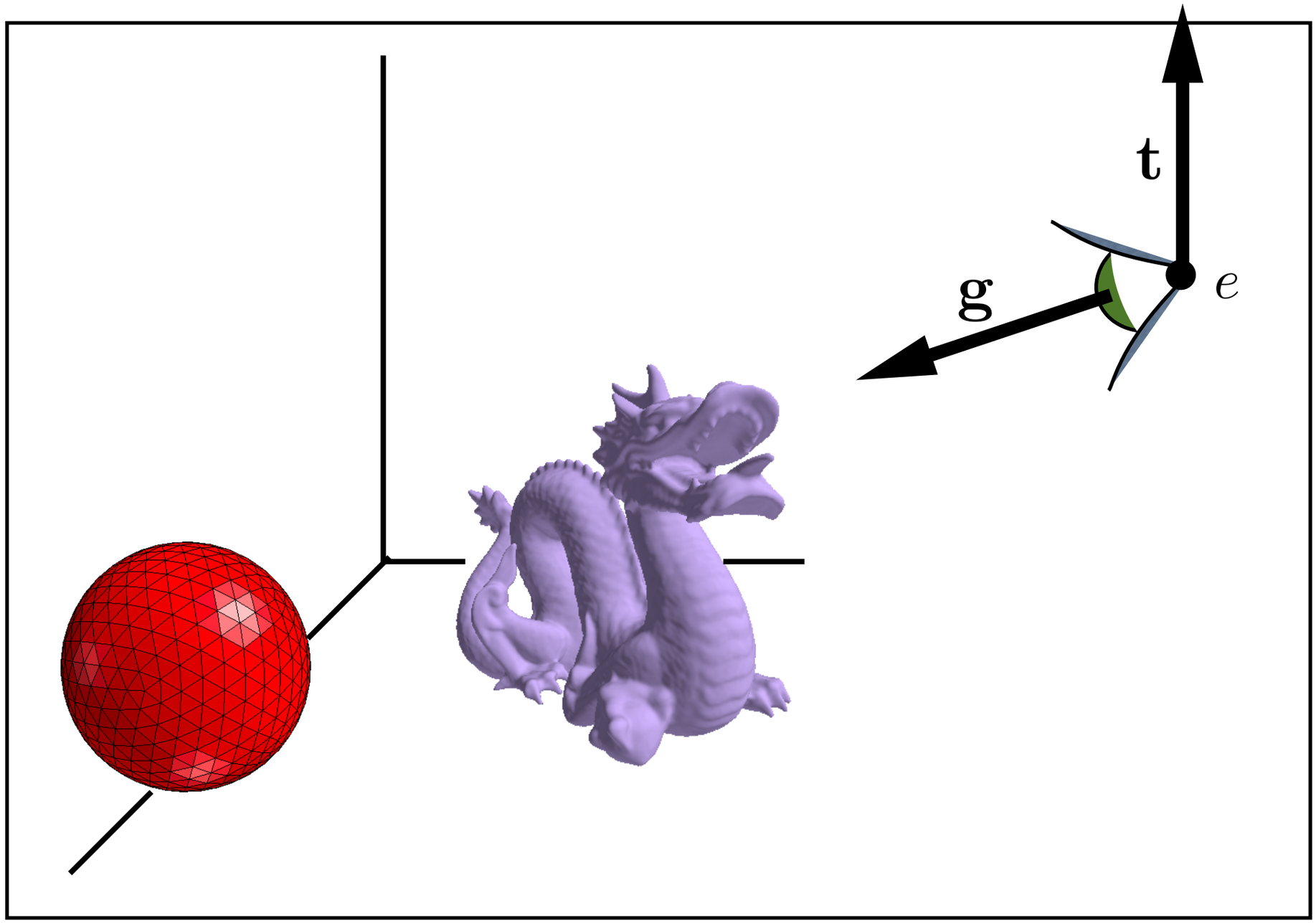
How do we specify the camera configuration? **up vector**



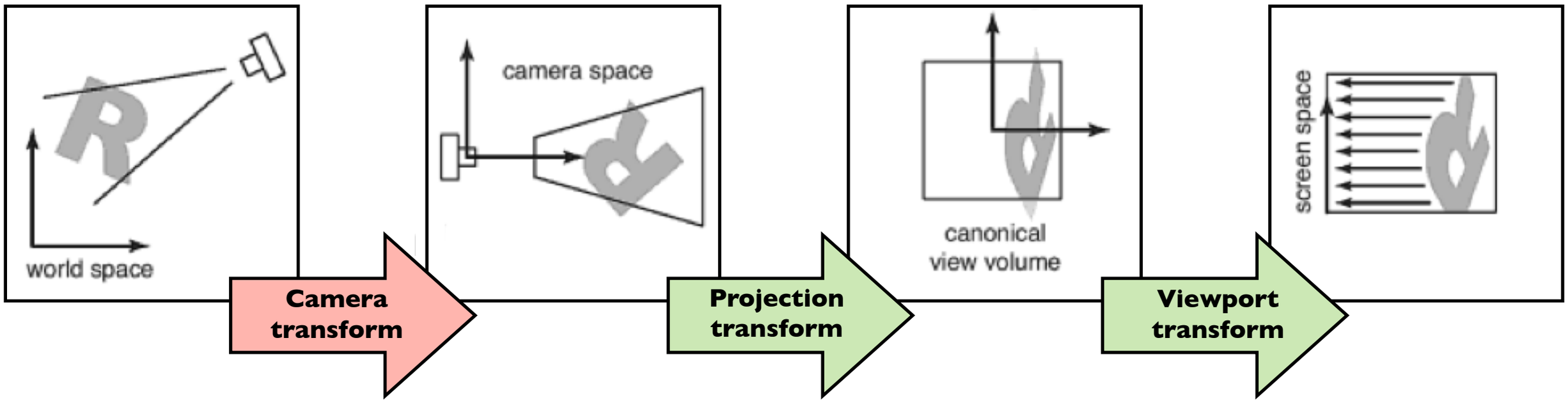


Camera Transform

How do we specify the camera configuration?



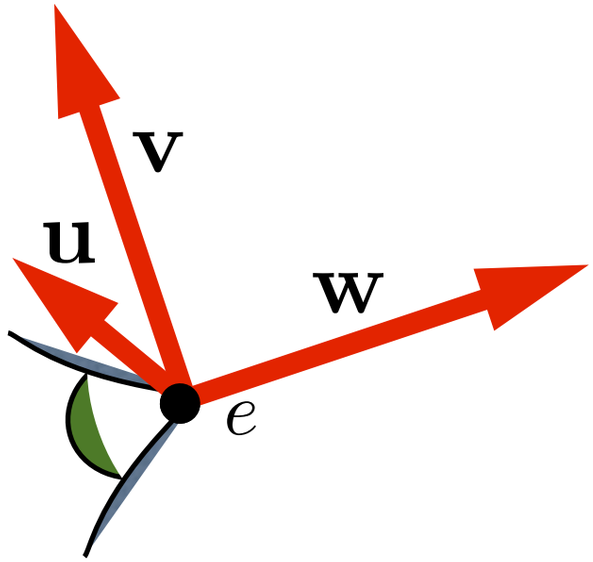
Camera Transform

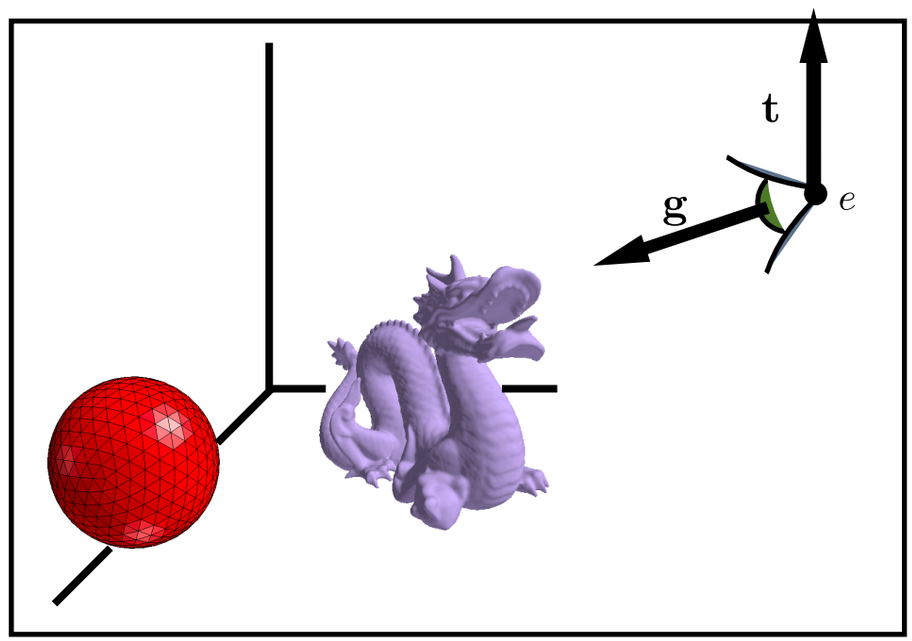


$$\mathbf{w} = -\frac{\mathbf{g}}{||\mathbf{g}||}$$

$$\mathbf{u} = \frac{\mathbf{t} \times \mathbf{w}}{||\mathbf{t} \times \mathbf{w}||}$$

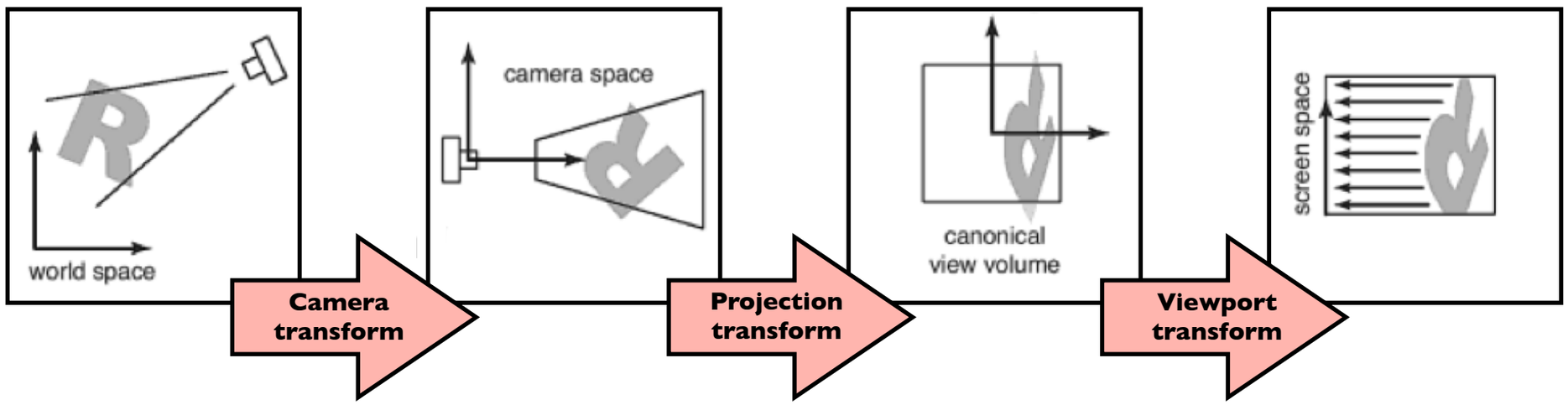
$$\mathbf{v} = \mathbf{w} \times \mathbf{u}$$





M_{cam} <whiteboard>

Line drawing algorithm



construct $M_{vp}\ M_{cam}$
construct M_{orth}
$M = M_{vp} M_{orth} M_{cam}$
for each line segment (a_i, b_i) do
    $\mathbf{p} = M\mathbf{a}_i$
    $\mathbf{q} = M\mathbf{b}_i$
drawline (x_p, y_p, x_q, y_q)

Shirley, Marschner 7.1

draw lines specified in <u>world</u> space

Graphics Pipeline