CS130 : Computer Graphics

Viewing Transformations

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2D Transformations

Uniform Scale

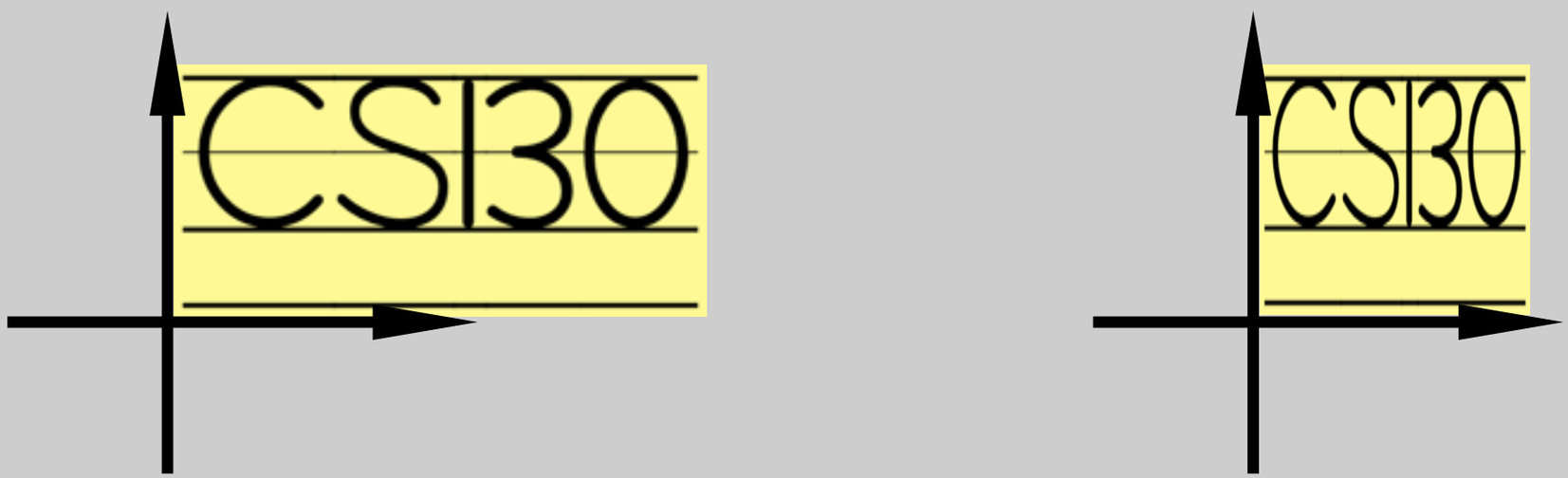
$$\begin{pmatrix} s & 0 \\ 0 & s \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} sx \\ sy \end{pmatrix}$$

$$\begin{pmatrix} .5 & 0 \\ 0 & .5 \end{pmatrix}$$

Nonuniform Scale

$$\begin{pmatrix} s_x & 0 \\ 0 & s_y \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} s_x x \\ s_y y \end{pmatrix}$$

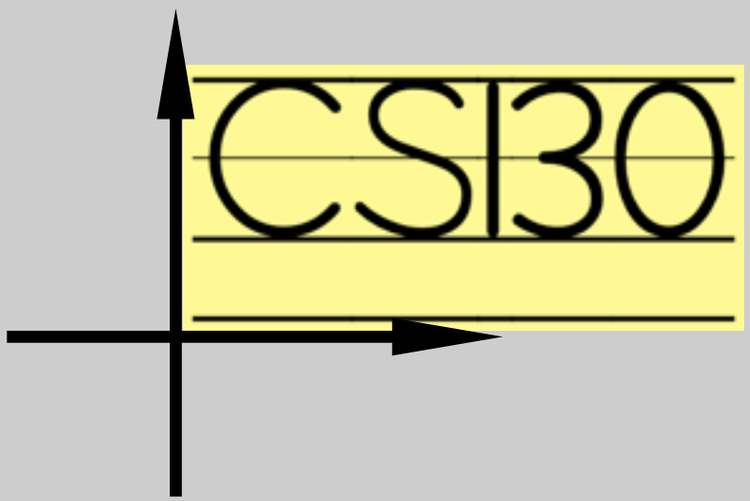
$$\begin{pmatrix} .5 & 0 \\ 0 & 1 \end{pmatrix}$$

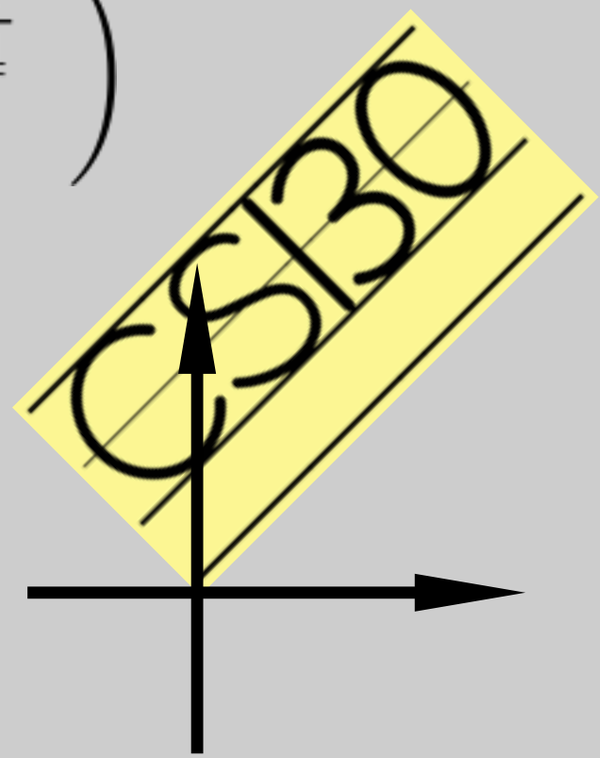


Rotation

$$\begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} x\cos\theta - y\sin\theta \\ x\sin\theta + y\cos\theta \end{pmatrix}$$

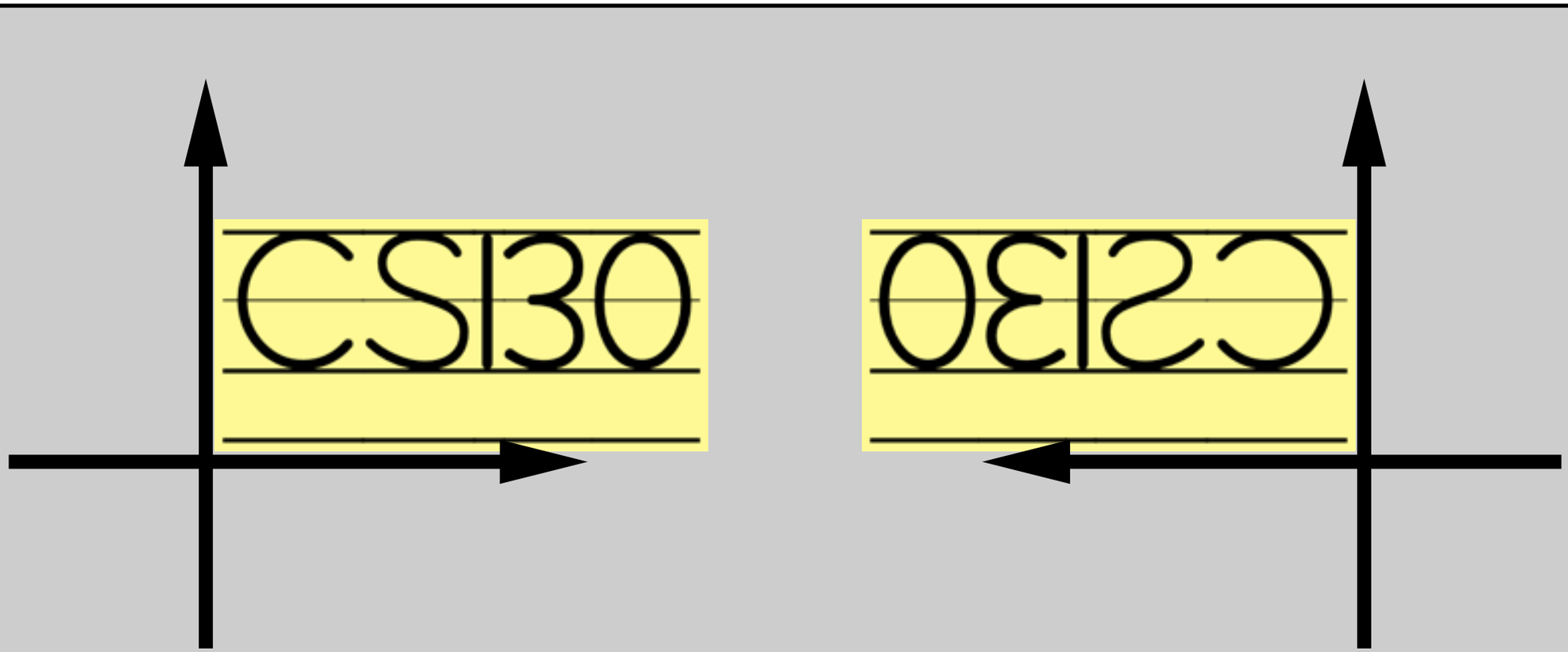
$$\begin{pmatrix} \cos\frac{\pi}{4} & -\sin\frac{\pi}{4} \\ \sin\frac{\pi}{4} & \cos\frac{\pi}{4} \end{pmatrix}$$





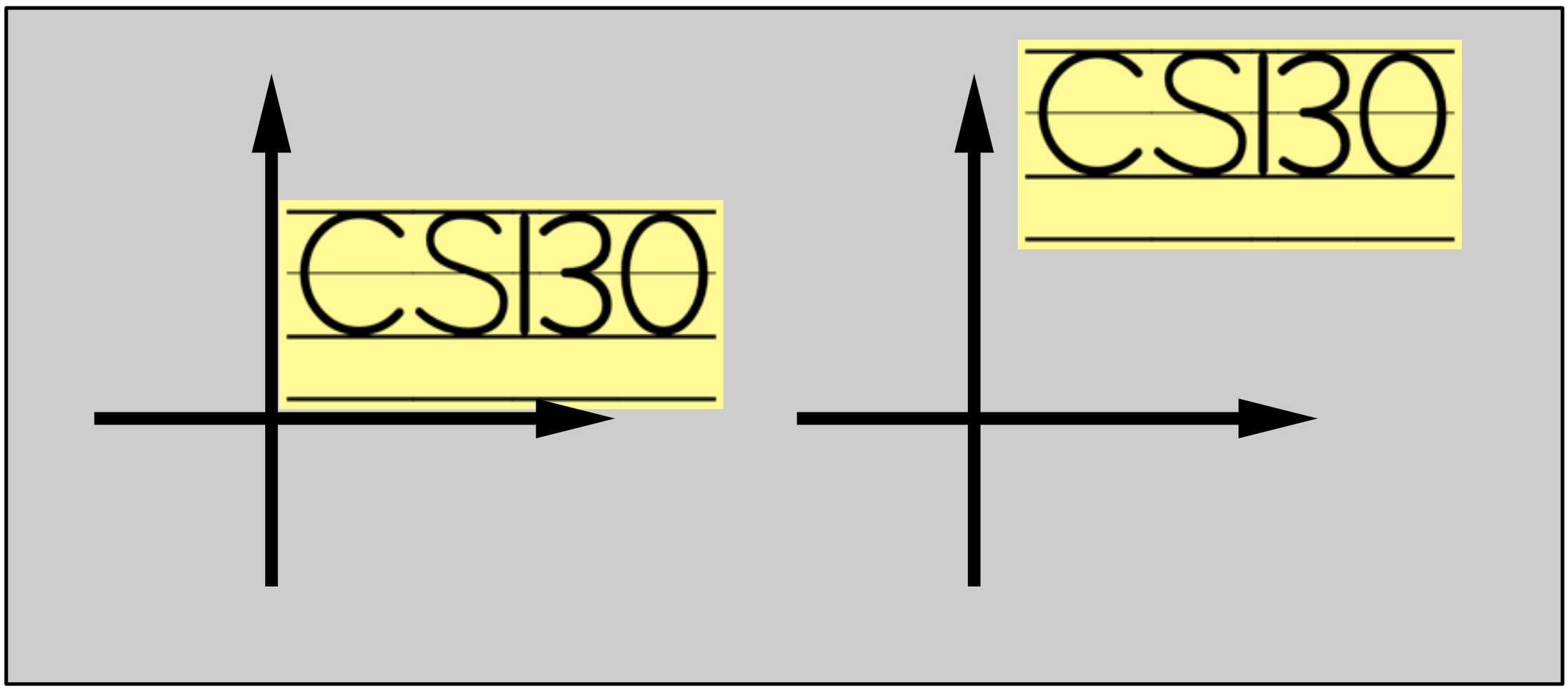
Reflection

$$\begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} -x \\ y \end{pmatrix}$$



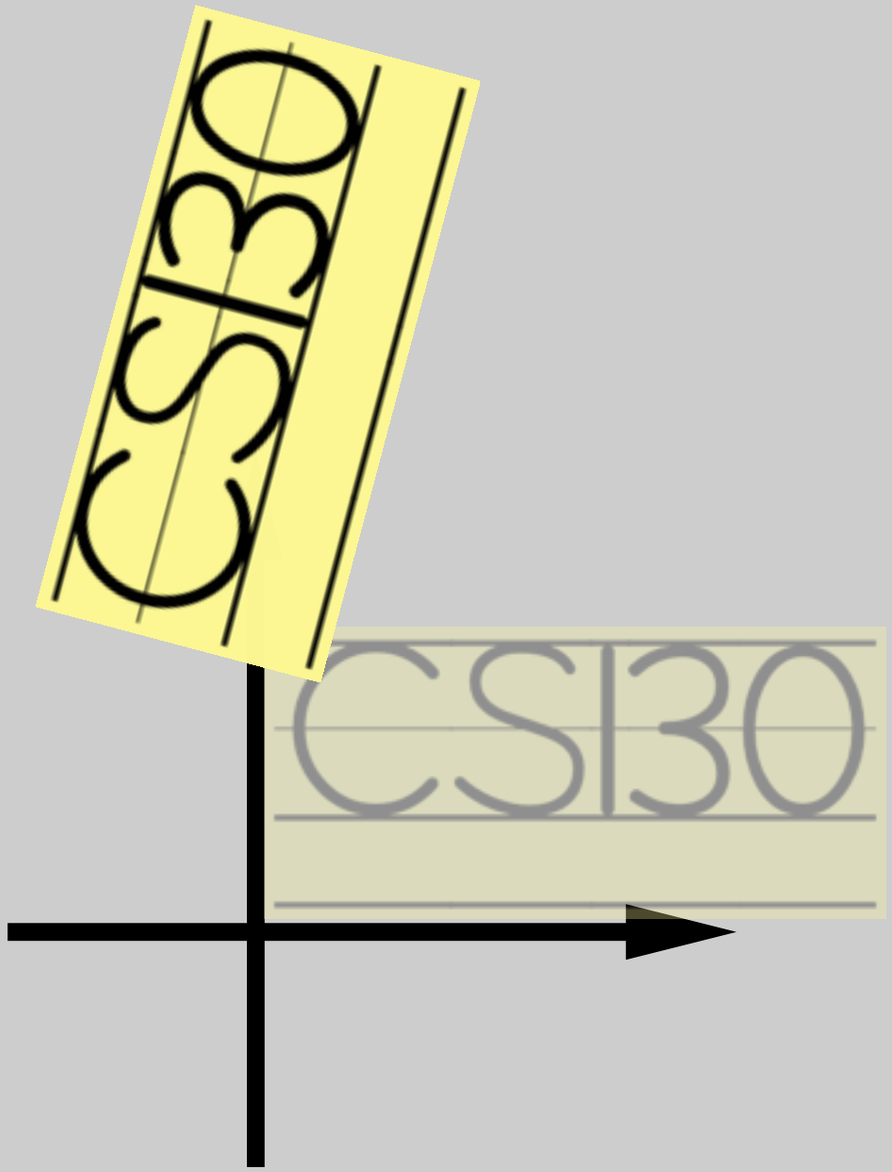
Translation

$$\begin{pmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix} = \begin{pmatrix} x + t_x \\ y + t_y \\ 1 \end{pmatrix}$$

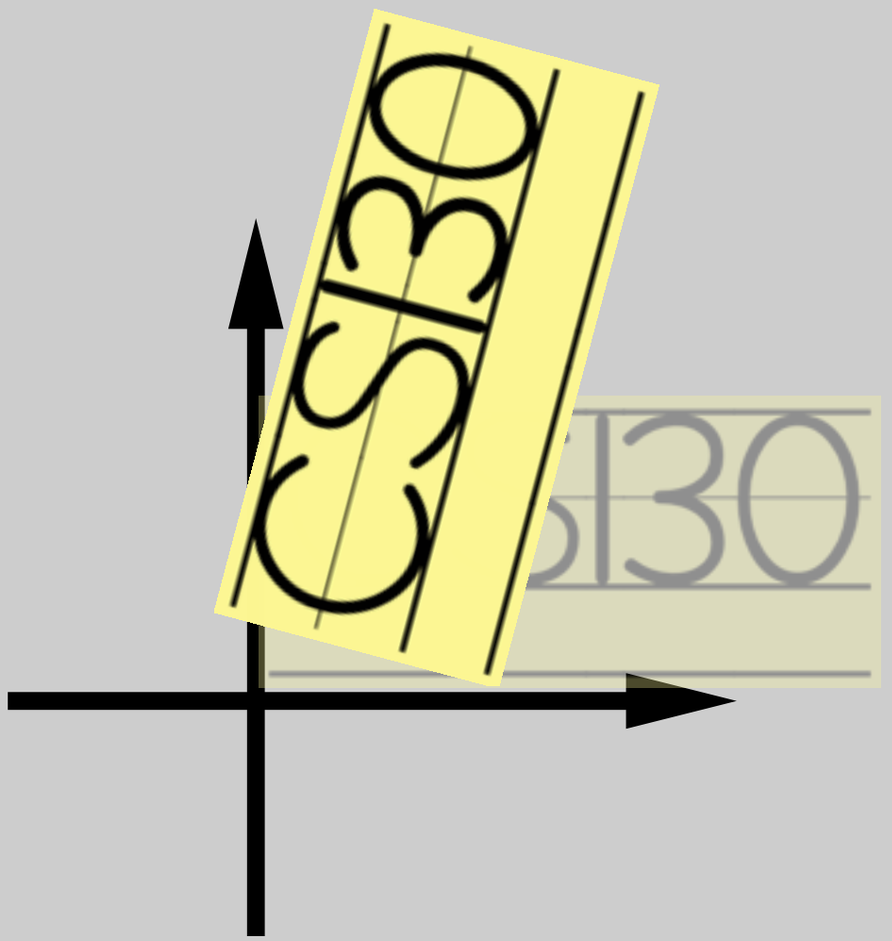


Noncommutativity

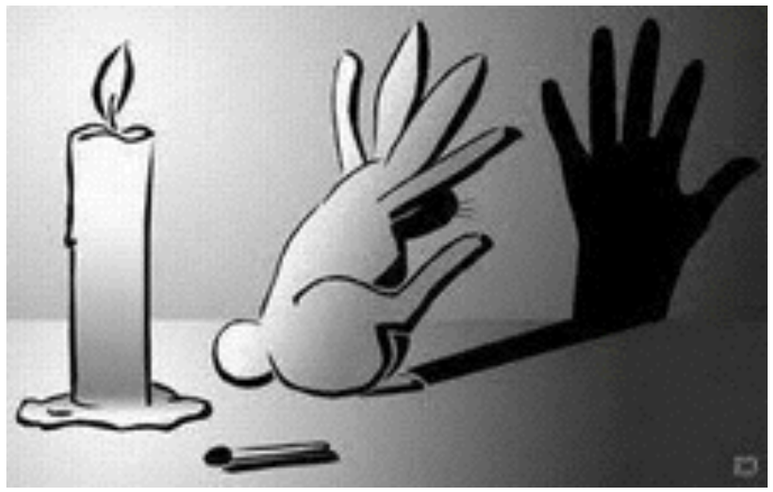
translate, rotate



rotate, translate

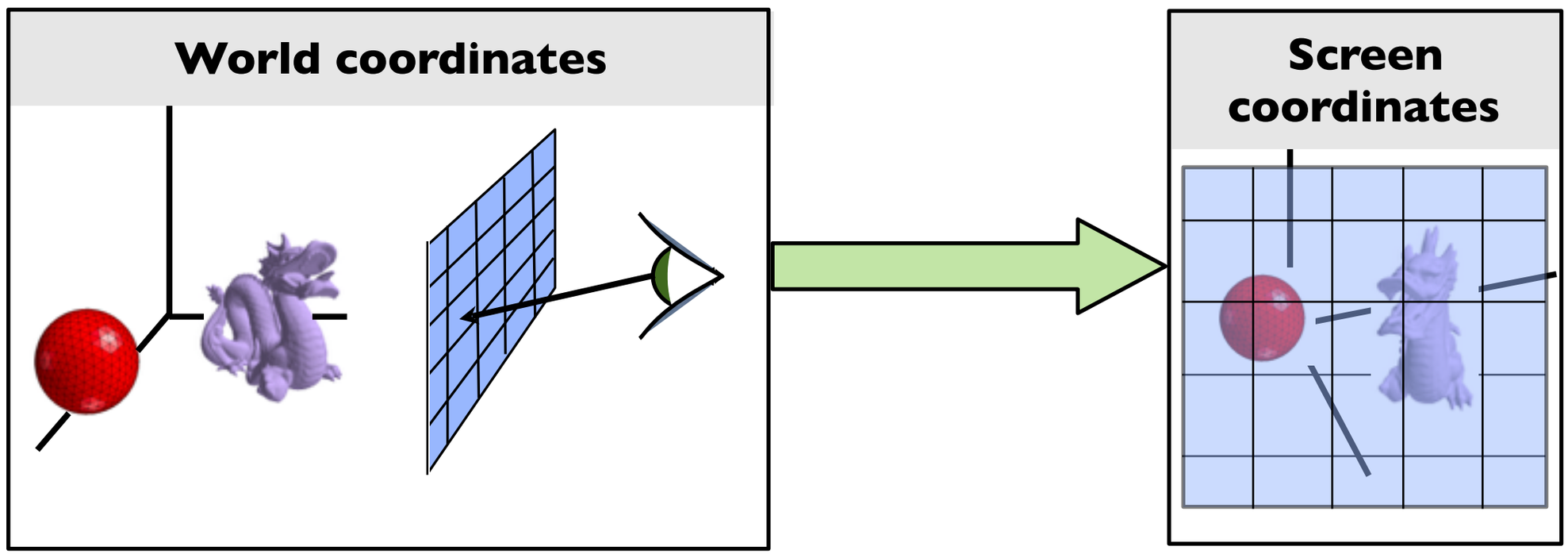


Viewing Transformations

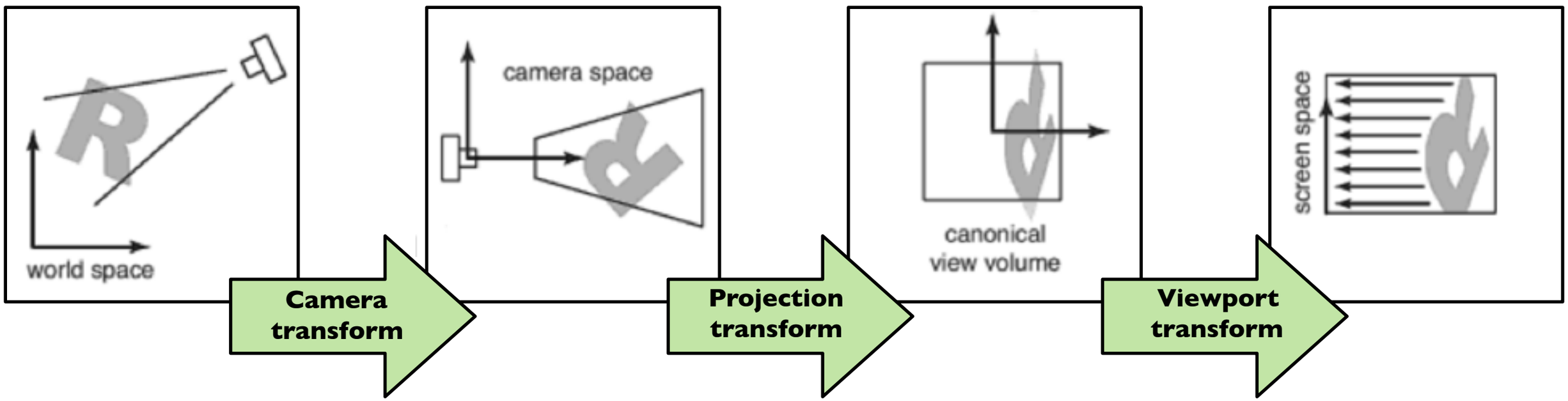


Viewing transformations

- Transform **vertices** from world coordinate descriptions to screen coordinate description



Decomposition of viewing transforms



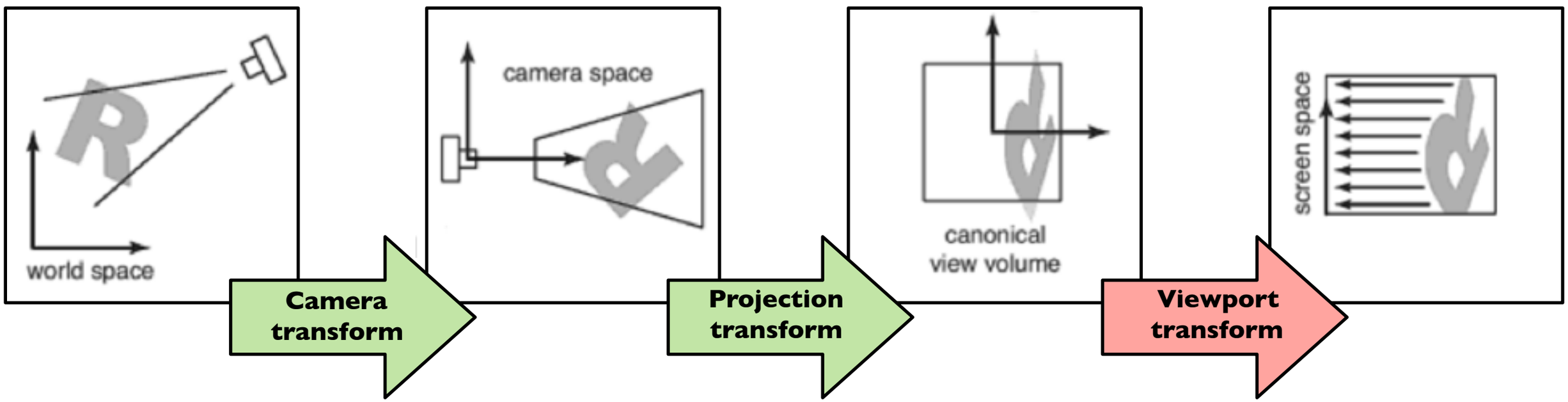
- rigid body transformation
- transform camera to origin

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

- map to pixel coordinates

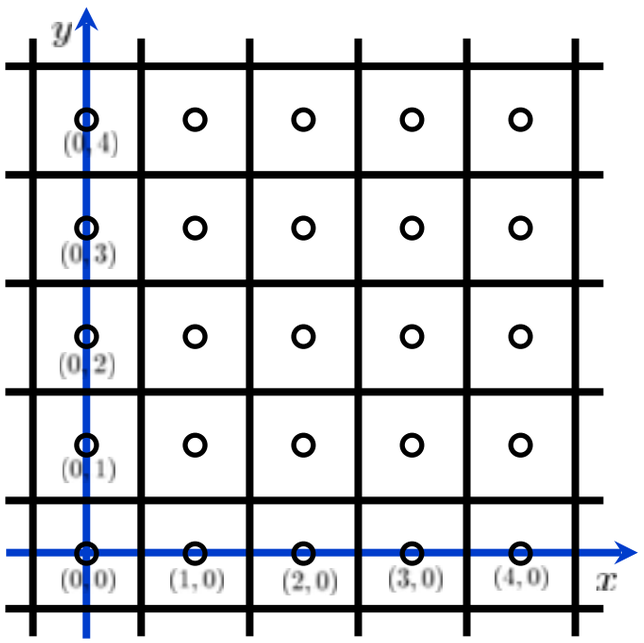
Viewing transforms depend on: camera position and orientation, type of projection, field of view, image resolution

Viewport transform

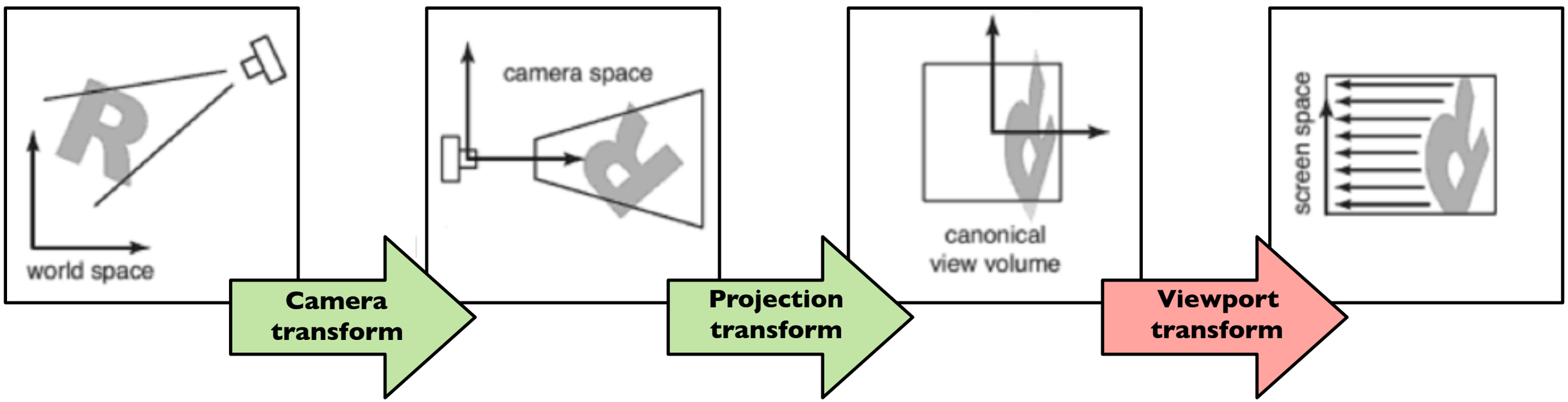


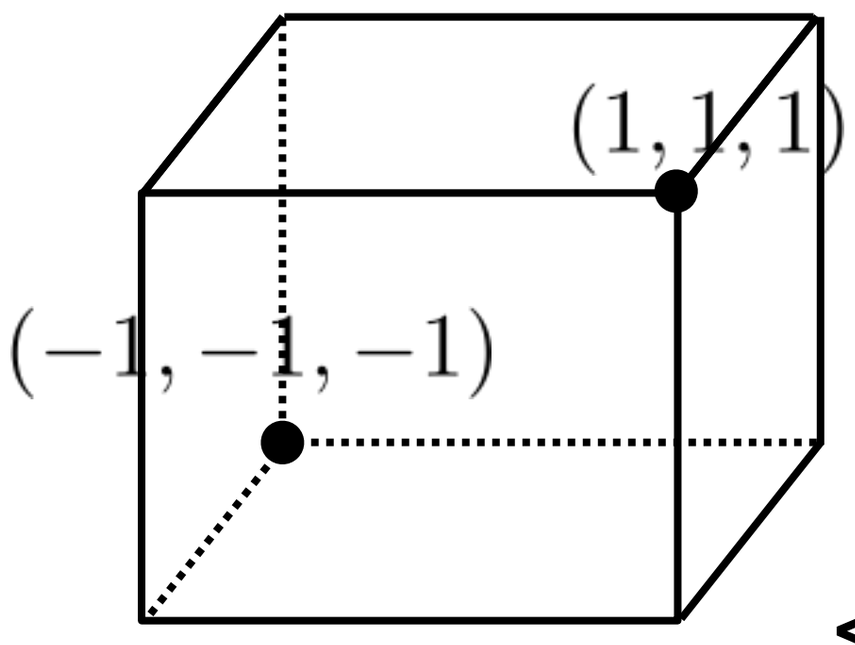
$$(x, y, z) \rightarrow (x', y', z')$$

$$(x, y, z) \in [-1, 1]^3 \qquad \begin{aligned} x' &\in [-.5, n_x - .5] \\ y' &\in [-.5, n_y - .5] \end{aligned}$$



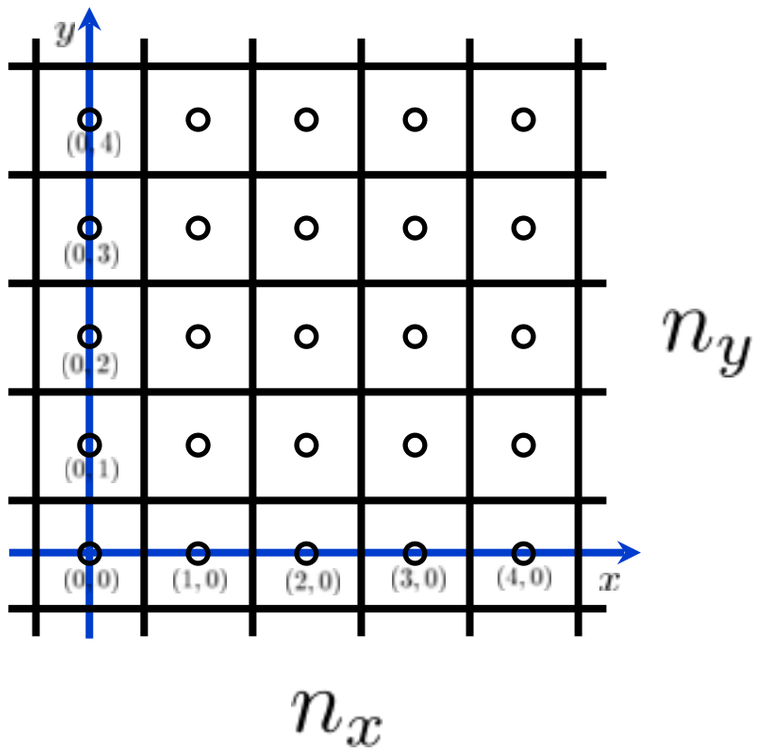
Viewport transform



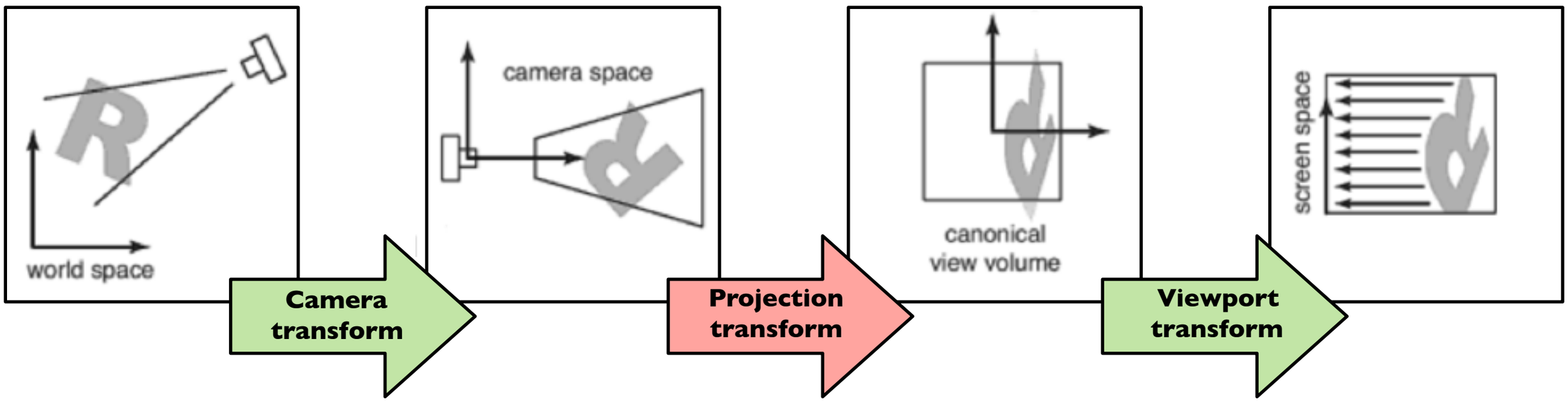


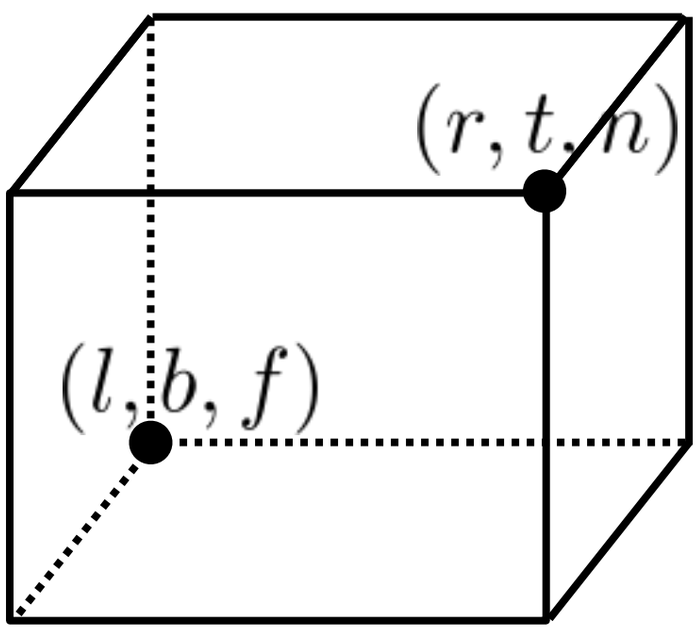
M_{vp}

<whiteboard>

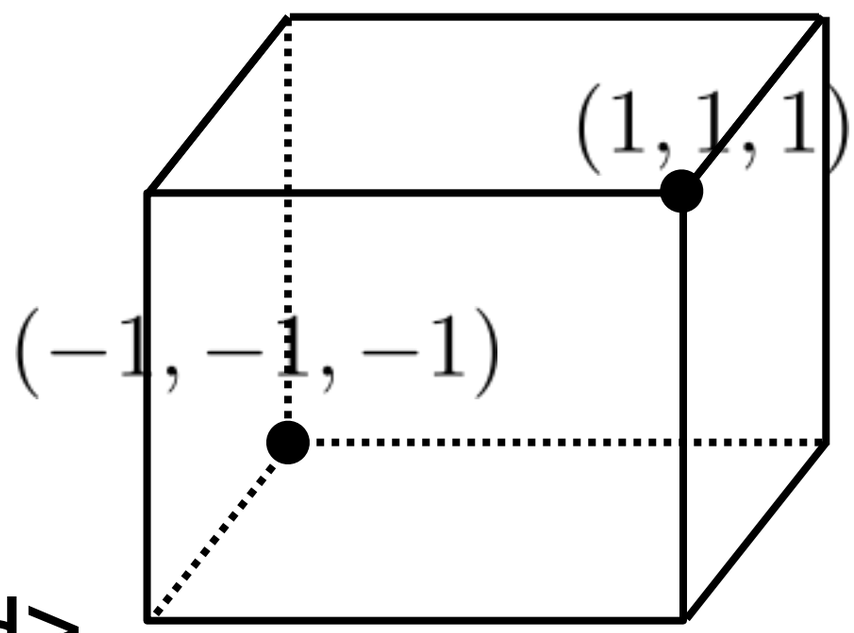


Orthographic Projection Transform





M_{orth}



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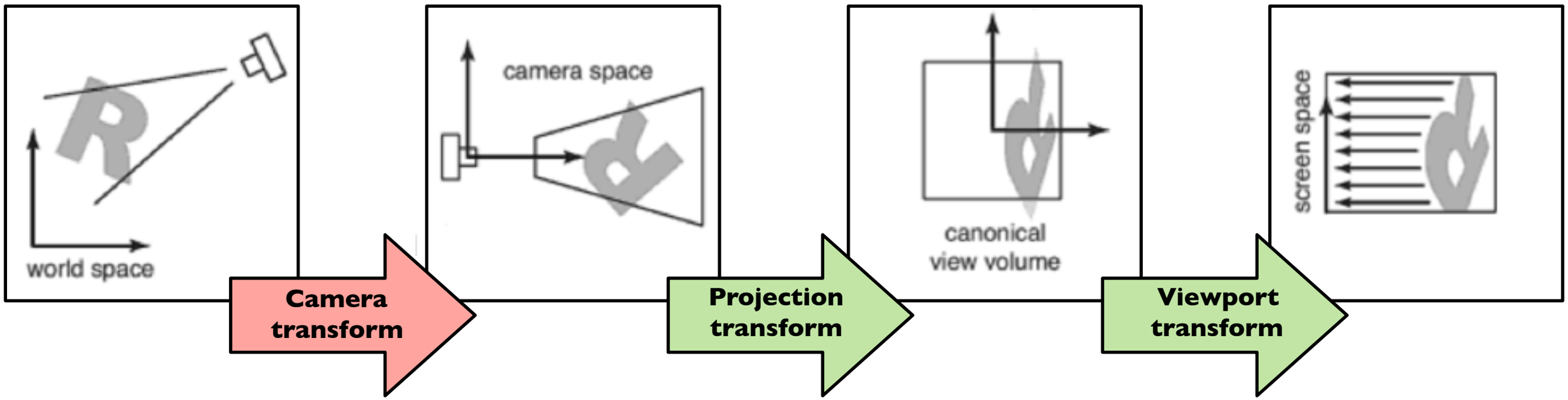
Camera Transform



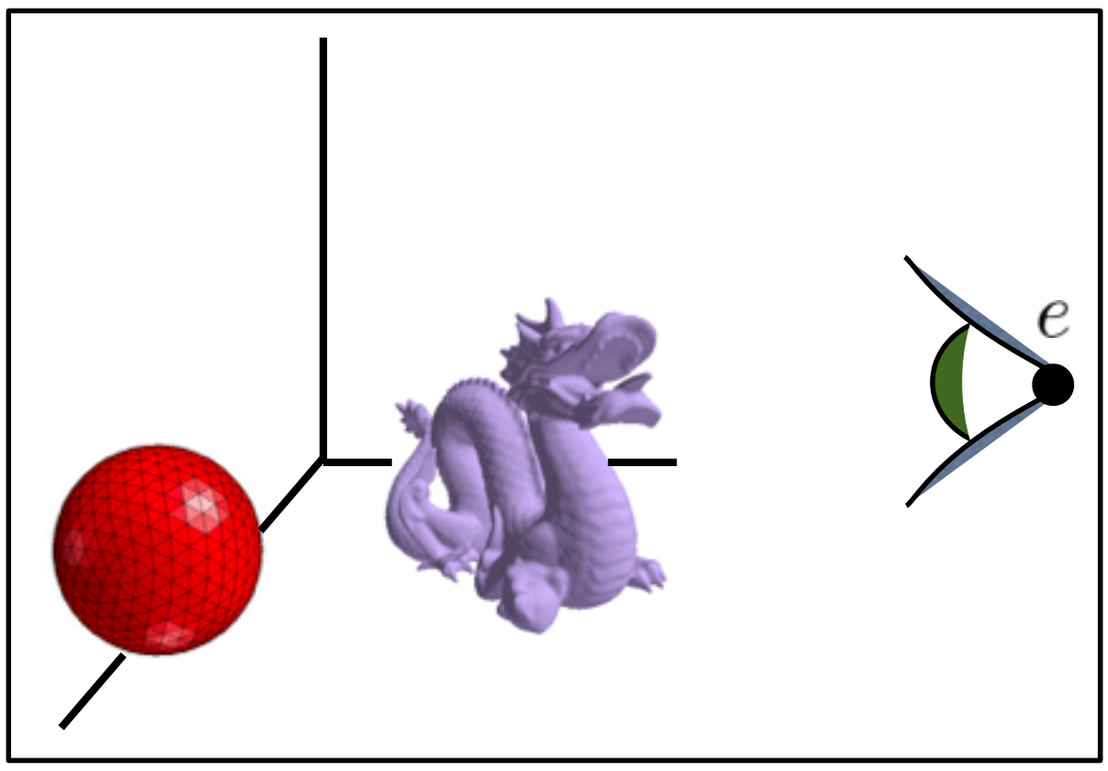
Camera Transform

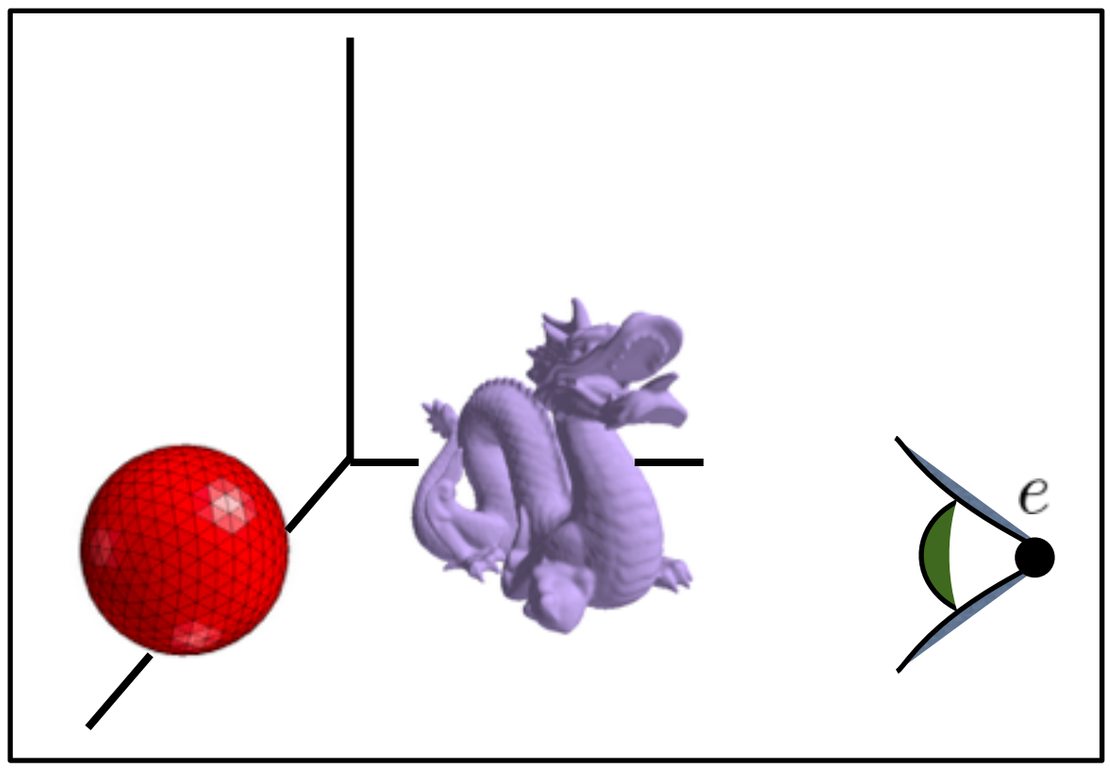
How do we specify the camera configuration?

Camera Transform

How do we specify the camera configuration?

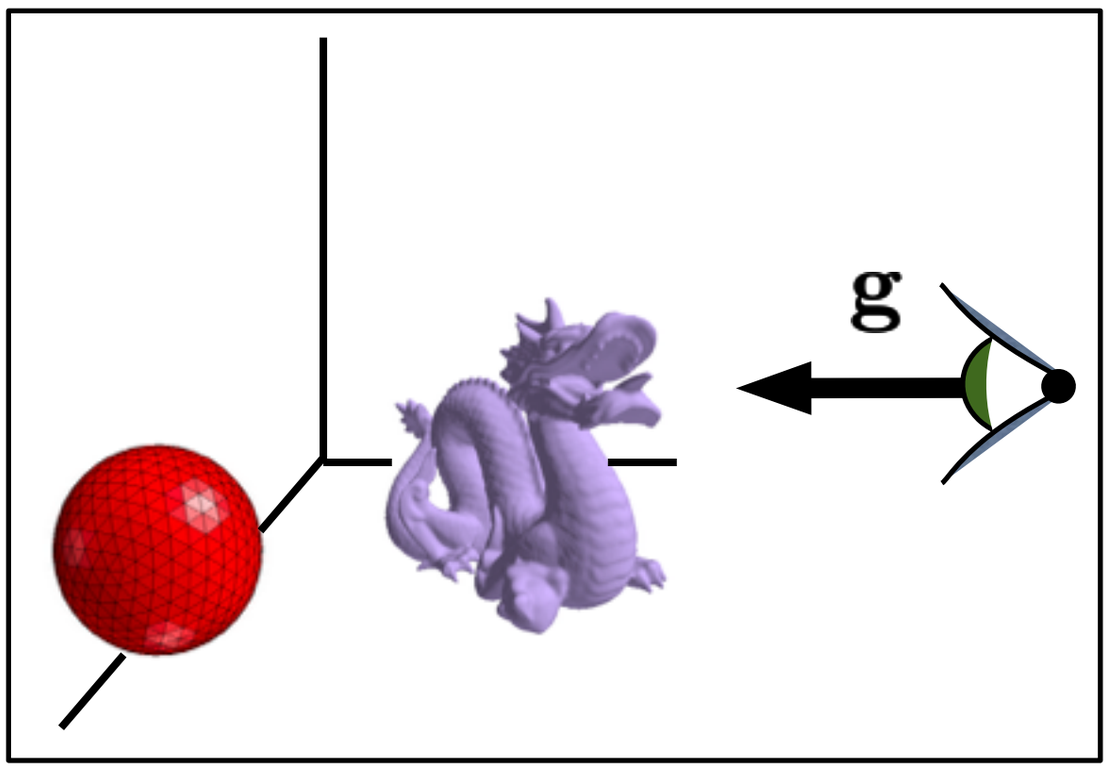
eye position

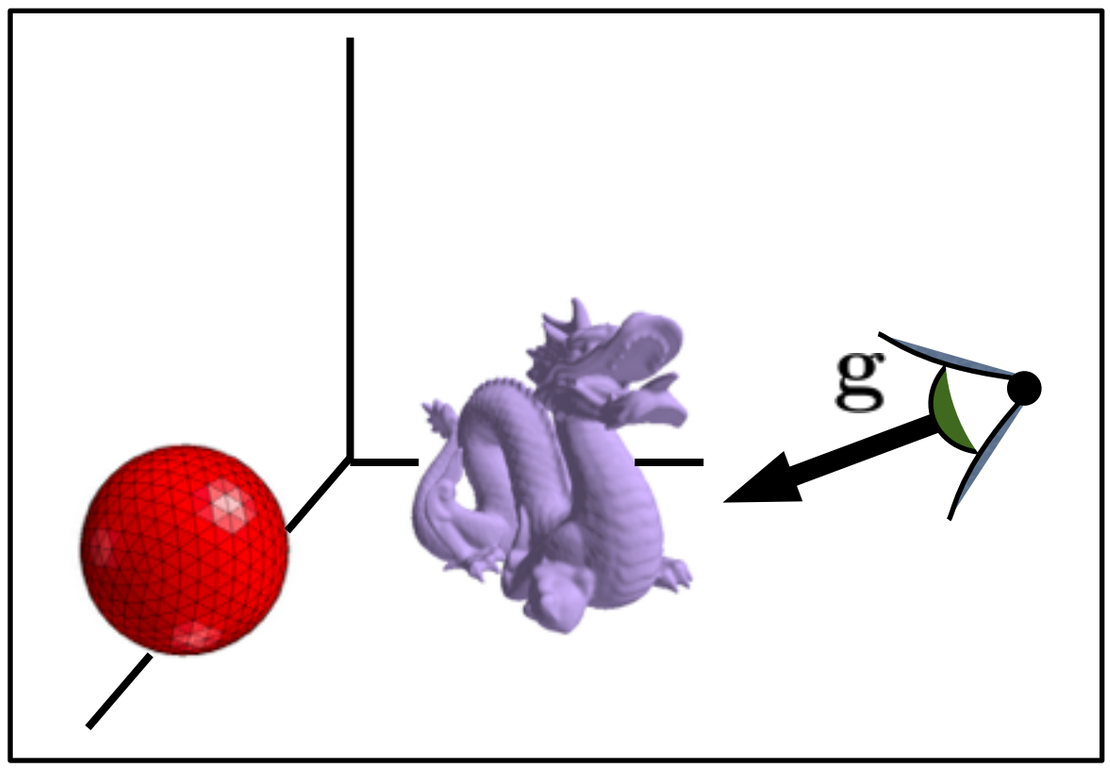




Camera Transform

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

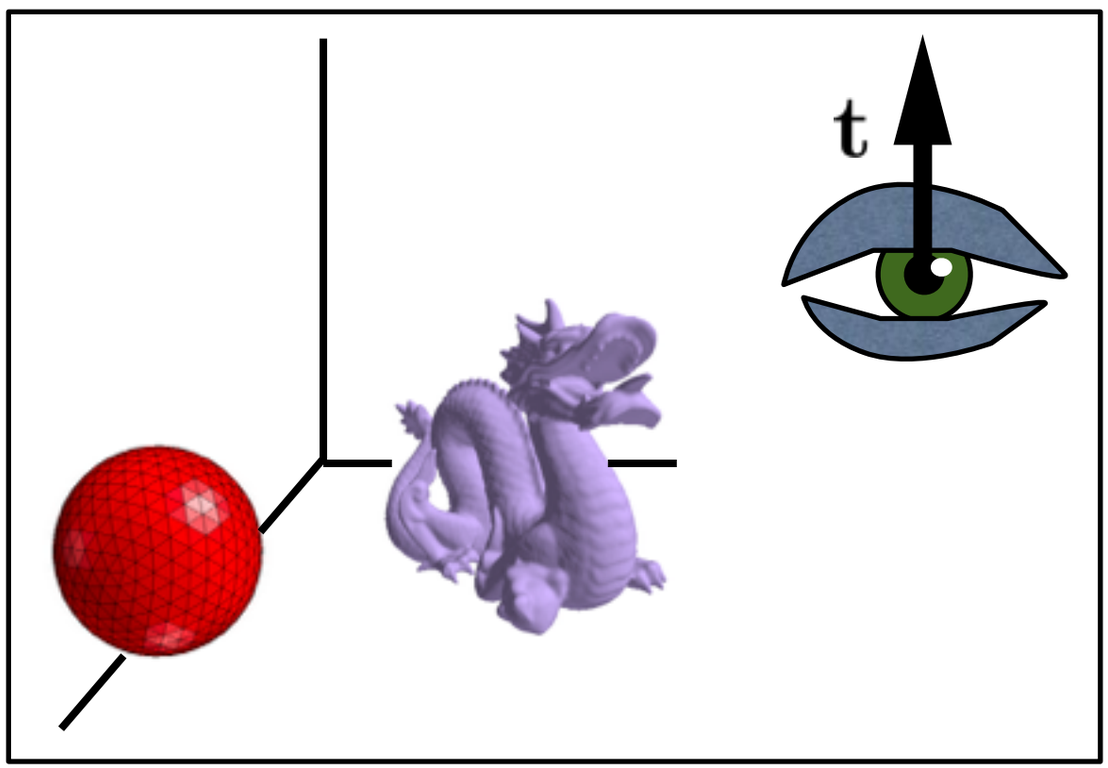


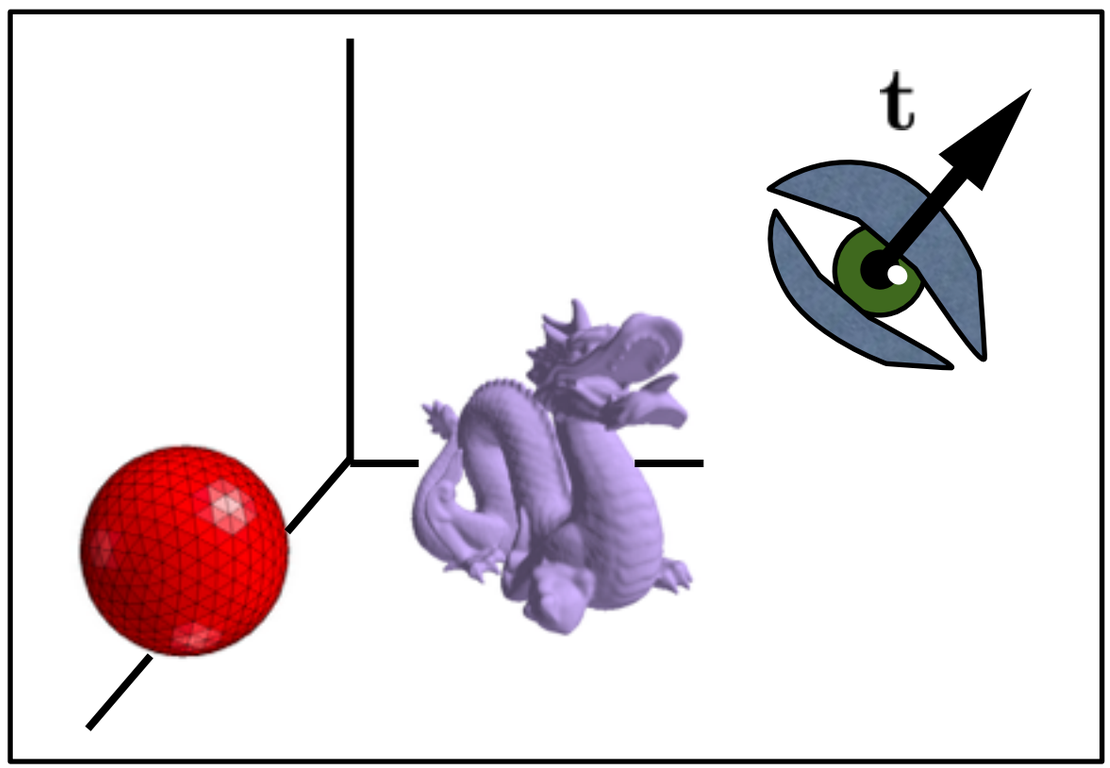


Camera Transform

How do we specify the camera configuration?

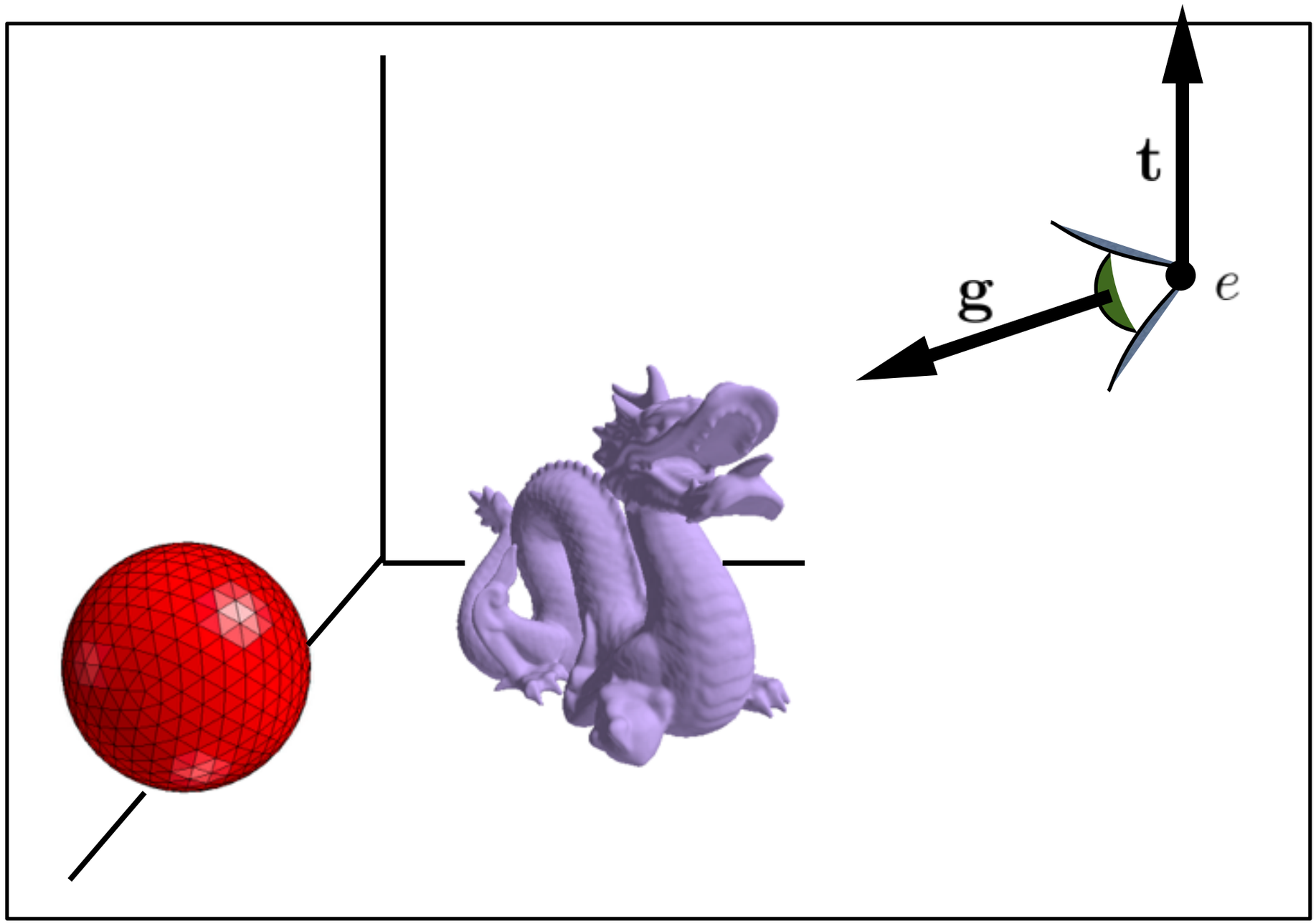
up vector



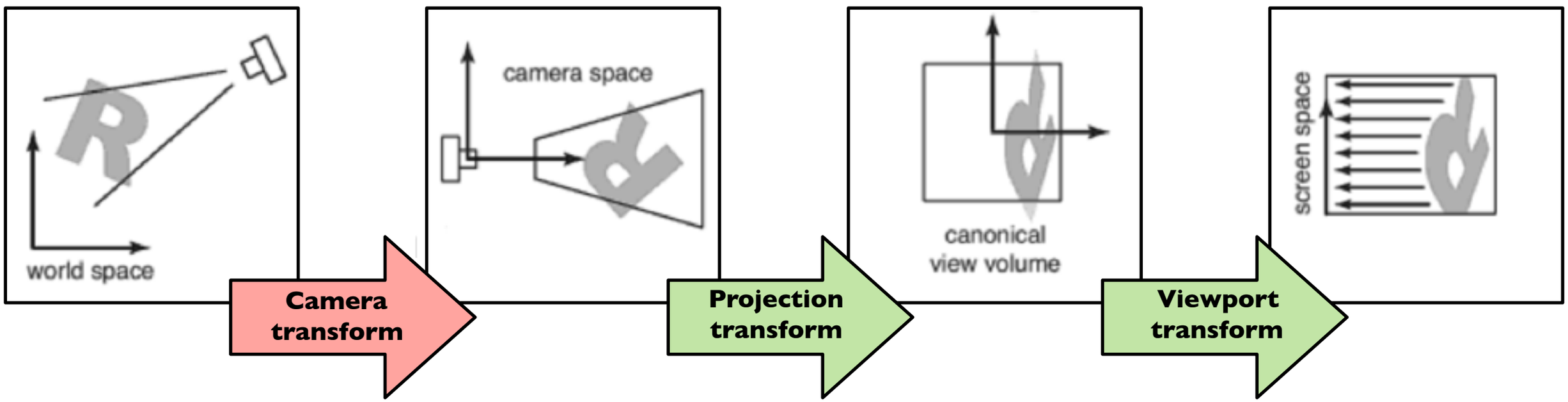


Camera Transform

How do we specify the camera configuration?



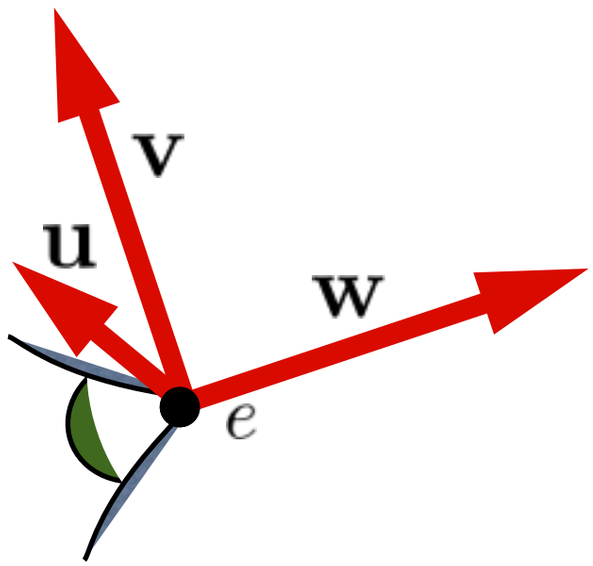
Camera Transform

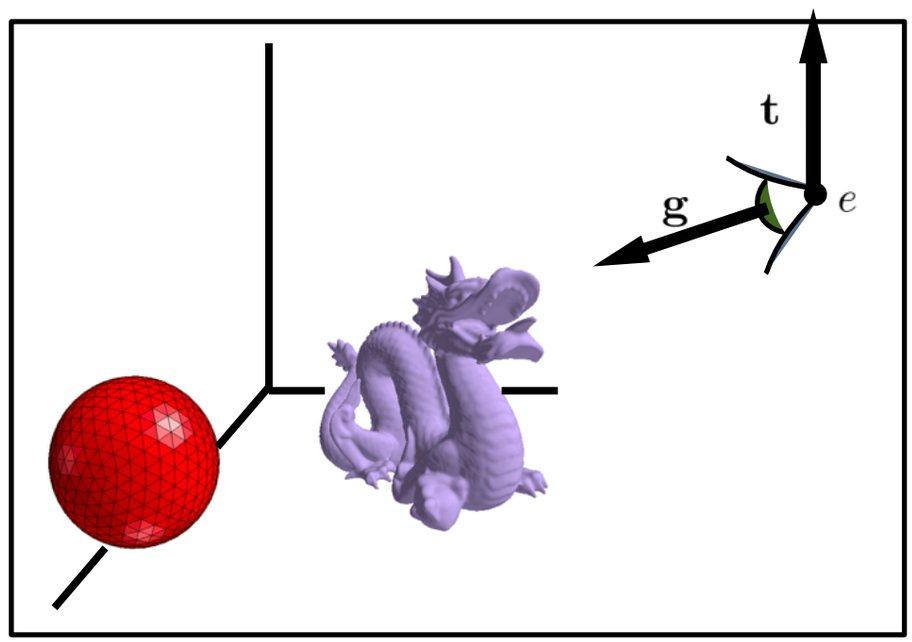


$$\mathbf{w} = -\frac{\mathbf{g}}{||\mathbf{g}||}$$

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

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





M_{cam} <whiteboard>