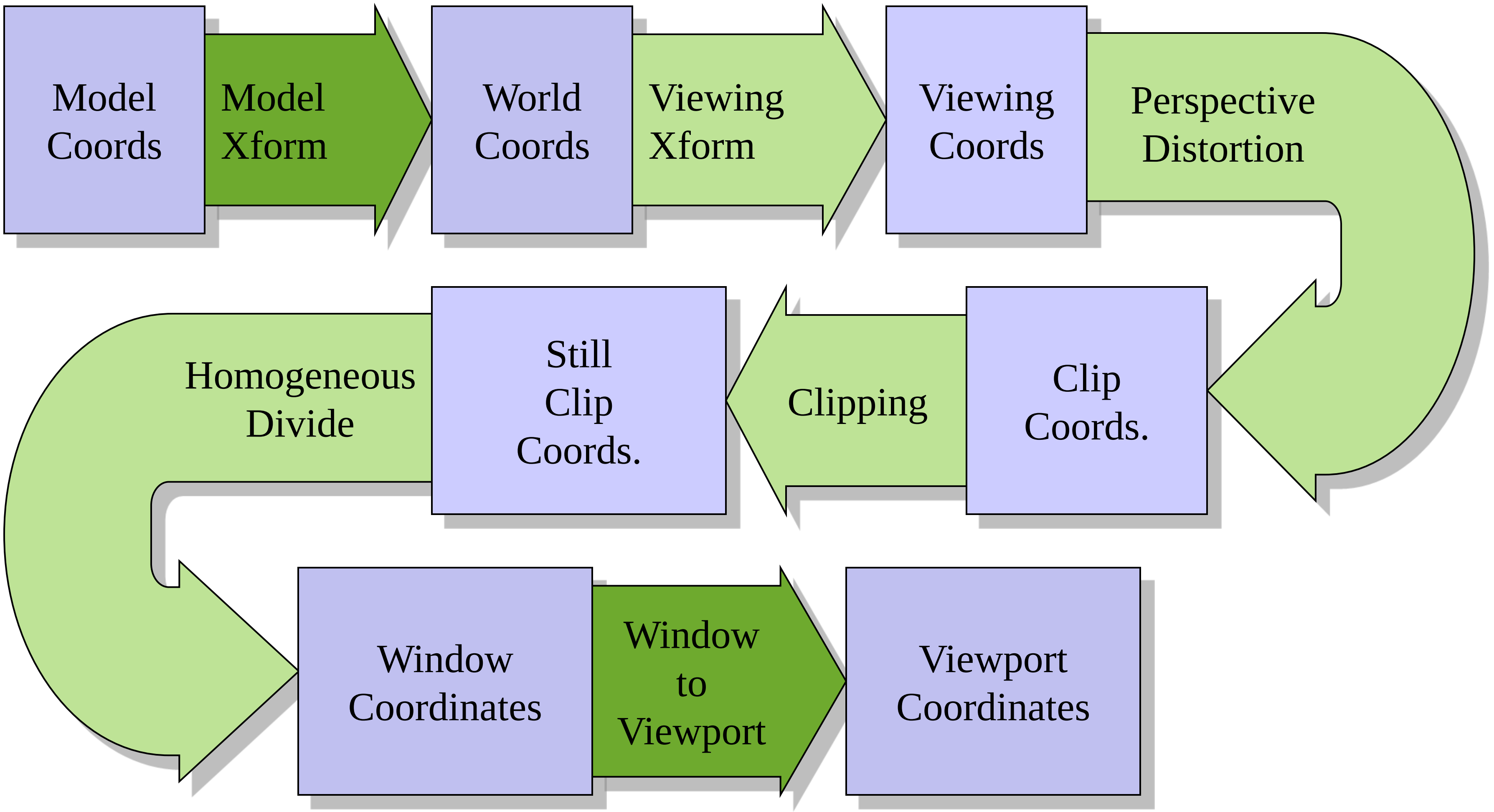
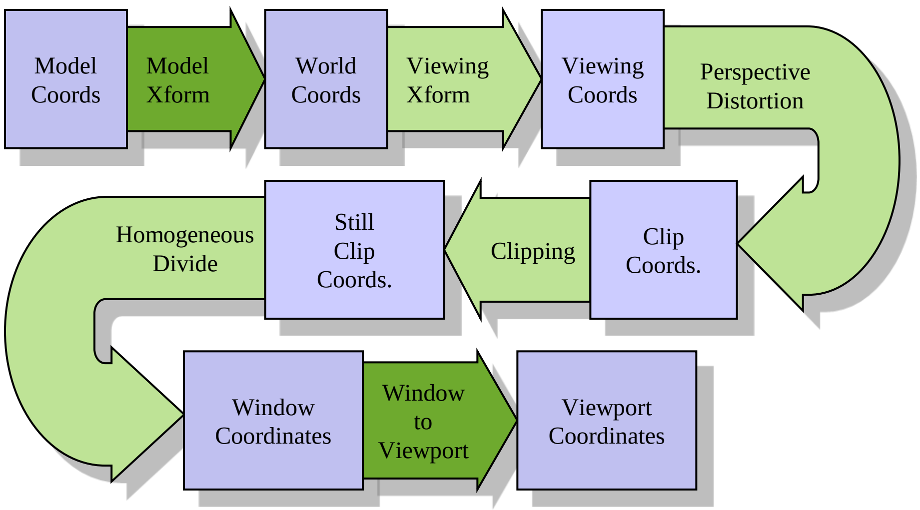
Viewing

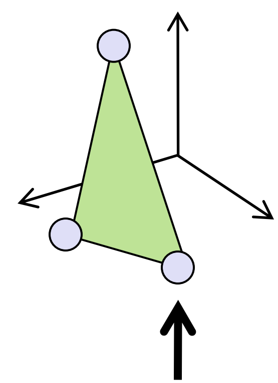
CS418 Computer Graphics
John C. Hart

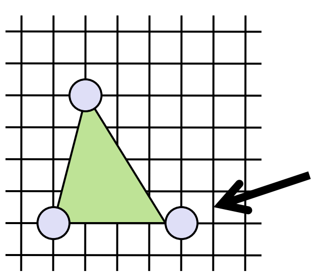
Graphics Pipeline



Graphics Pipeline

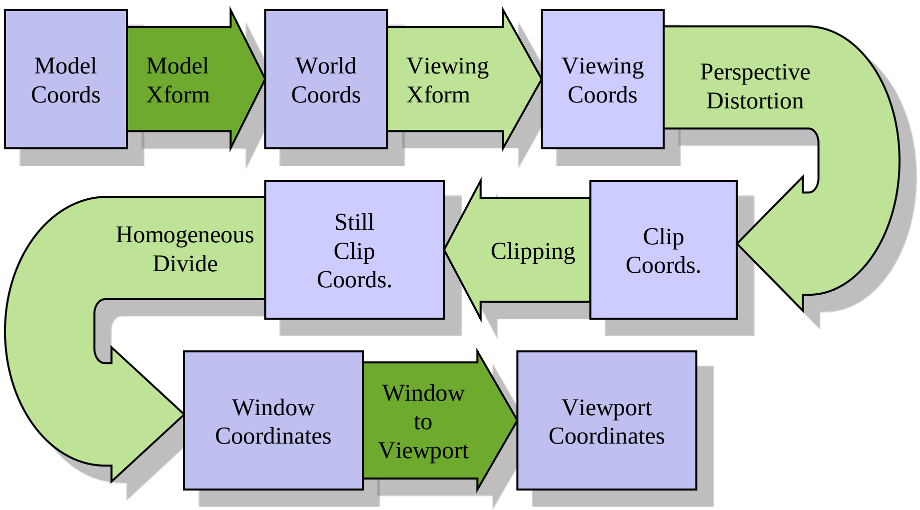


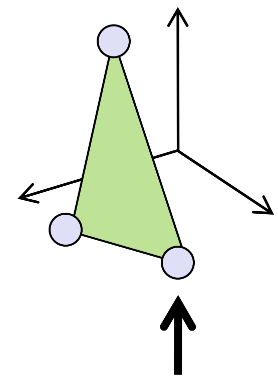


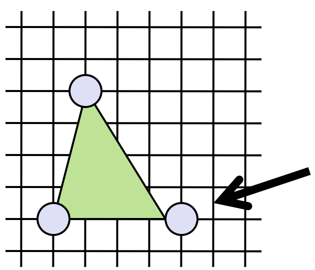


$$\begin{bmatrix} x_s \\ y_s \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} \text{W2V} \end{bmatrix} \begin{bmatrix} \text{Persp} \end{bmatrix} \begin{bmatrix} \text{View} \end{bmatrix} \begin{bmatrix} \text{Model} \end{bmatrix} \begin{bmatrix} x_m \\ y_m \\ z_m \\ 1 \end{bmatrix}$$

Graphics Pipeline



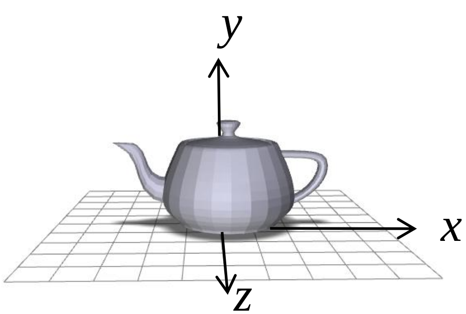




$$\begin{bmatrix} x_s \\ y_s \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} & & & \\ & \mathbf{M} & & \\ & & & \end{bmatrix} \begin{bmatrix} x_m \\ y_m \\ z_m \\ 1 \end{bmatrix}$$

Transformation Order

glutSolidTeapot(1);



$$\begin{bmatrix} x_s \\ y_s \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} \mathrm{M} \end{bmatrix} \begin{bmatrix} x_m \\ y_m \\ z_m \\ 1 \end{bmatrix}$$

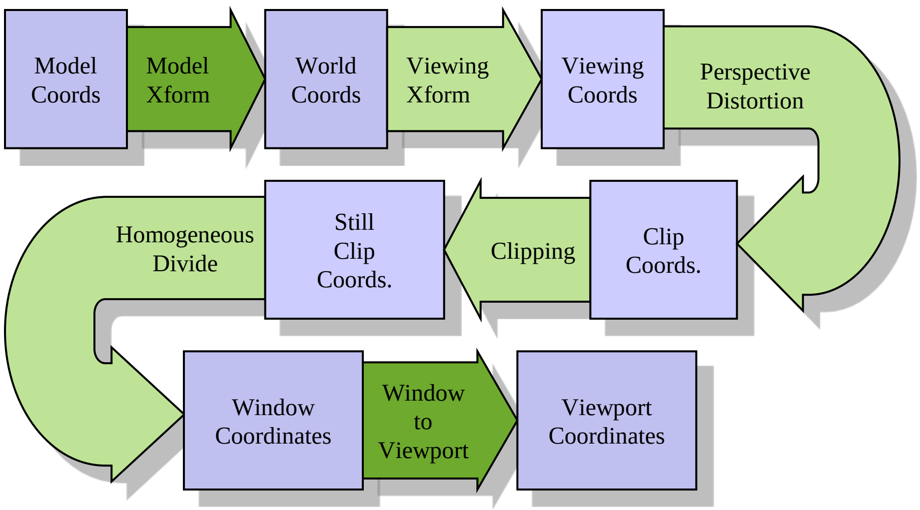
glRotate3f(-90, 0,0,1);
glTranslate3f(0,1,0);
glutSolidTeapot(1);

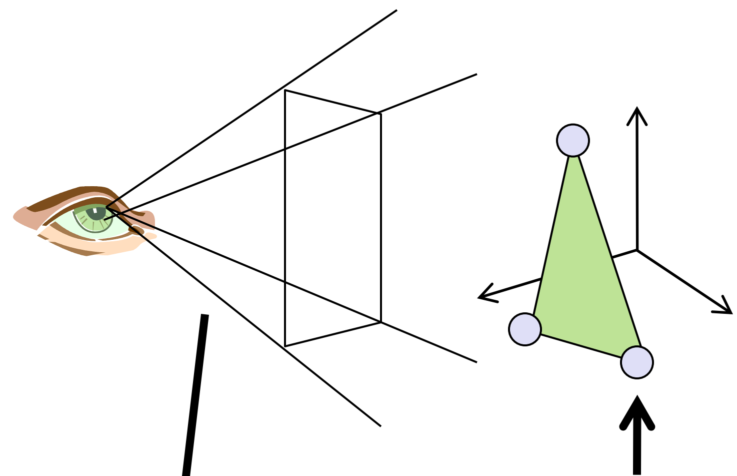
$$\begin{bmatrix} x_s \\ y_s \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} \mathrm{M} \end{bmatrix} \begin{bmatrix} \mathrm{R} \end{bmatrix} \begin{bmatrix} \mathrm{T} \end{bmatrix} \begin{bmatrix} x_m \\ y_m \\ z_m \\ 1 \end{bmatrix}$$

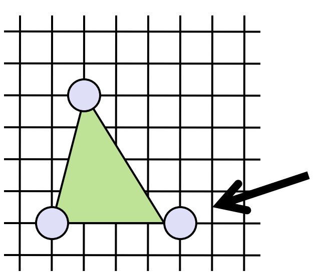
glTranslate3f(0,1,0);
glRotate3f(-90, 0,0,1);
glutSolidTeapot(1);

$$\begin{bmatrix} x_s \\ y_s \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} \mathrm{M} \end{bmatrix} \begin{bmatrix} \mathrm{T} \end{bmatrix} \begin{bmatrix} \mathrm{R} \end{bmatrix} \begin{bmatrix} x_m \\ y_m \\ z_m \\ 1 \end{bmatrix}$$

Viewing Transformation

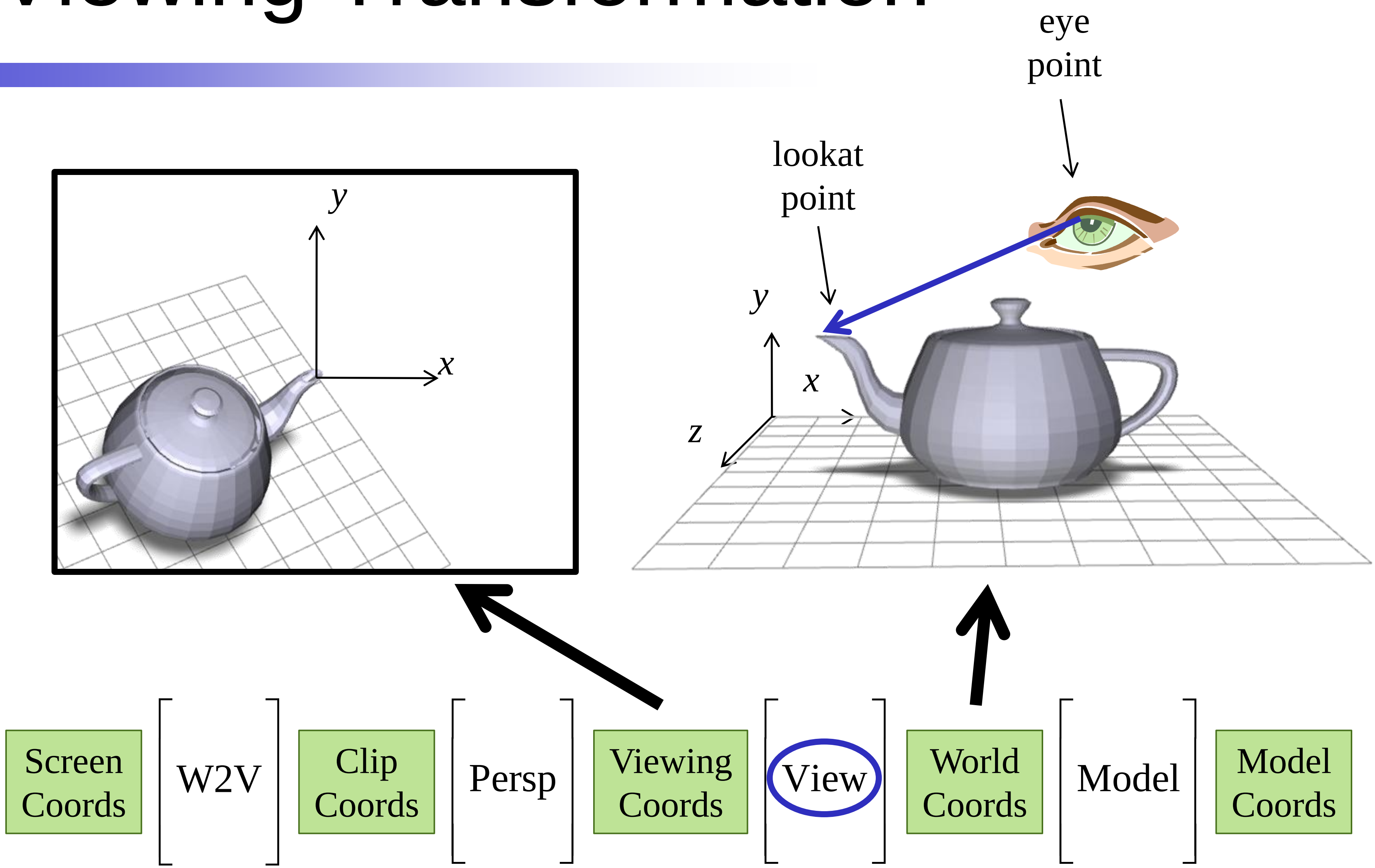




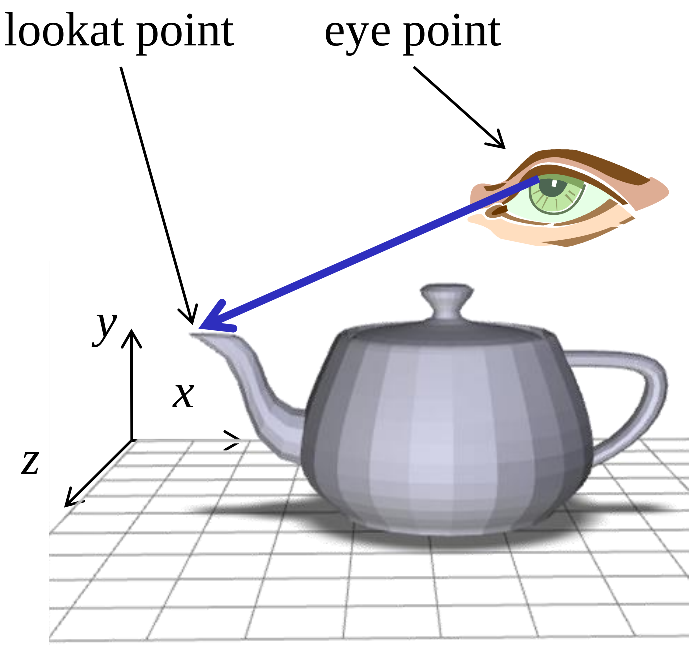


$$\begin{bmatrix} x_s \\ y_s \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} \text{W2V} \end{bmatrix} \begin{bmatrix} \text{Persp} \end{bmatrix} \begin{bmatrix} \text{View} \end{bmatrix} \begin{bmatrix} \text{Model} \end{bmatrix} \begin{bmatrix} x_m \\ y_m \\ z_m \\ 1 \end{bmatrix}$$

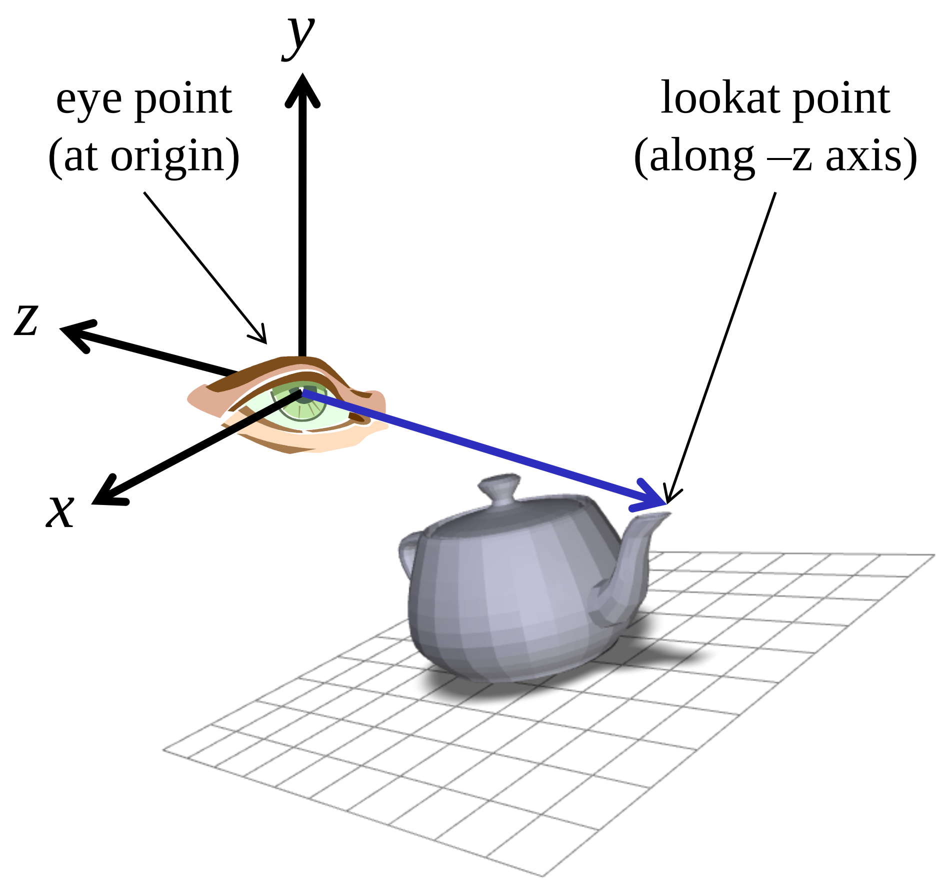
Viewing Transformation



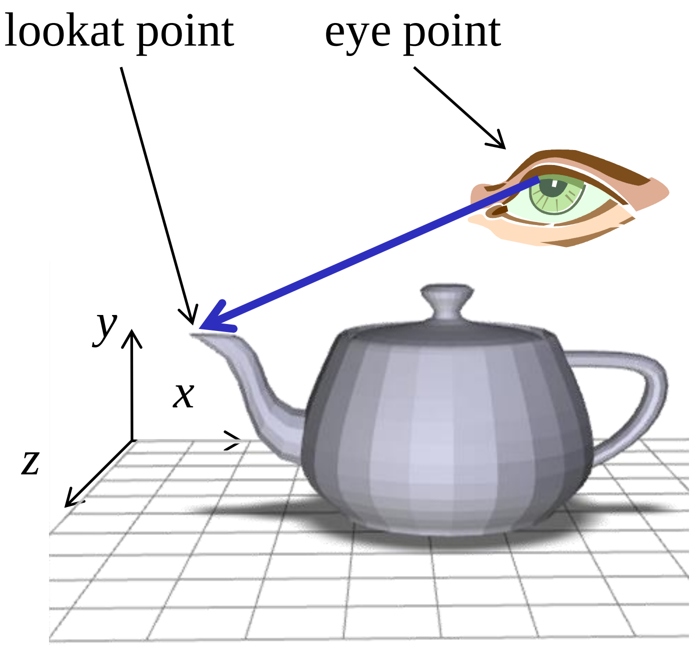
World Coordinates



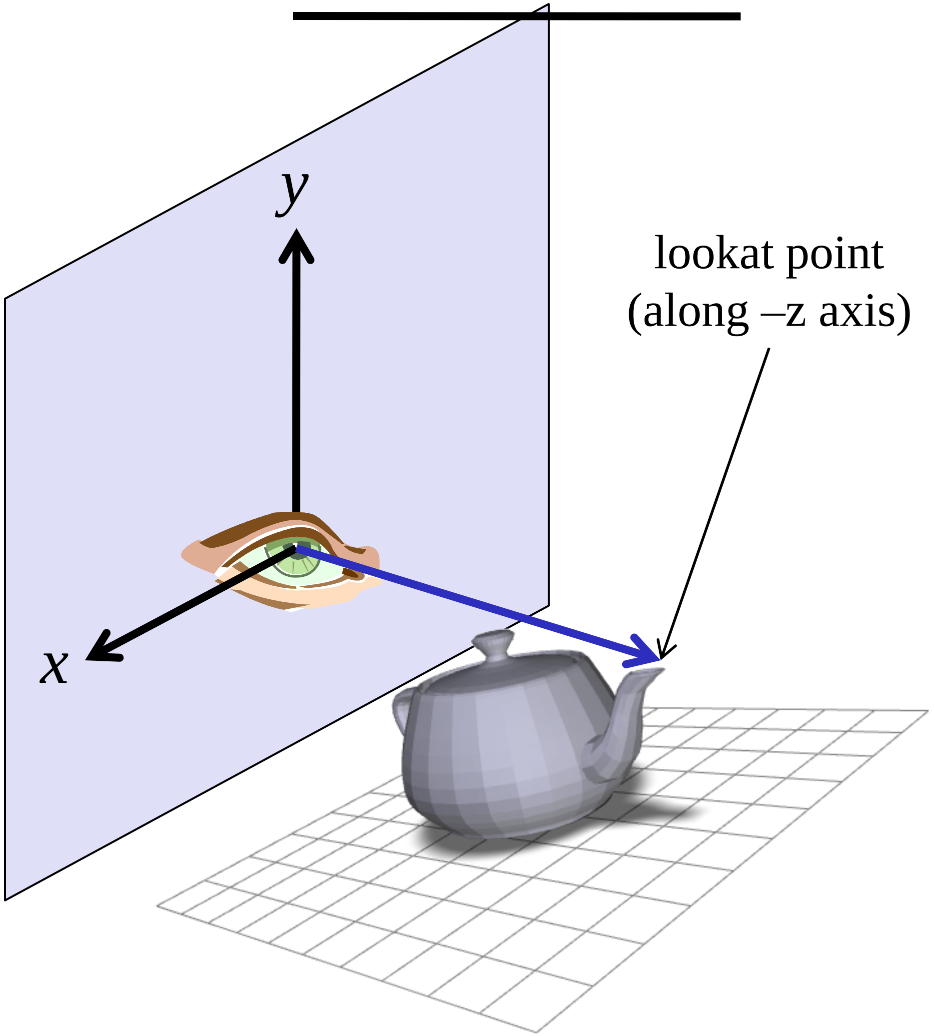
Viewing Coordinates



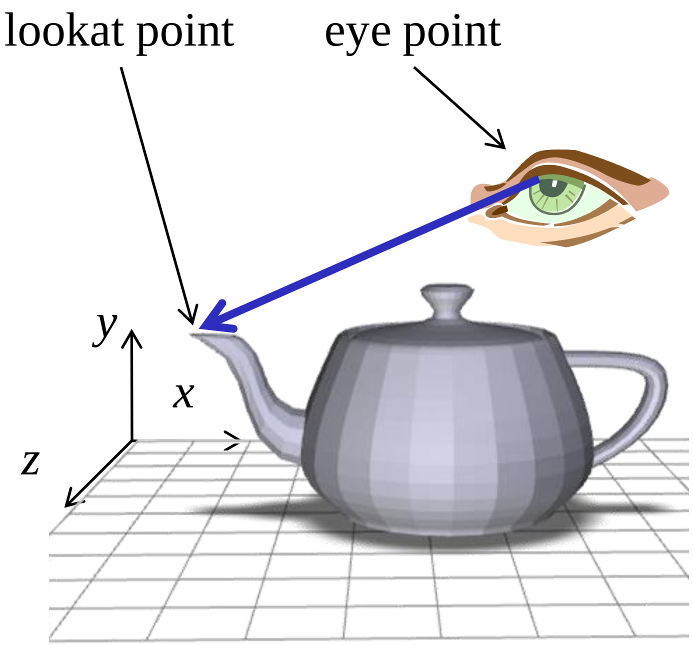
World Coordinates



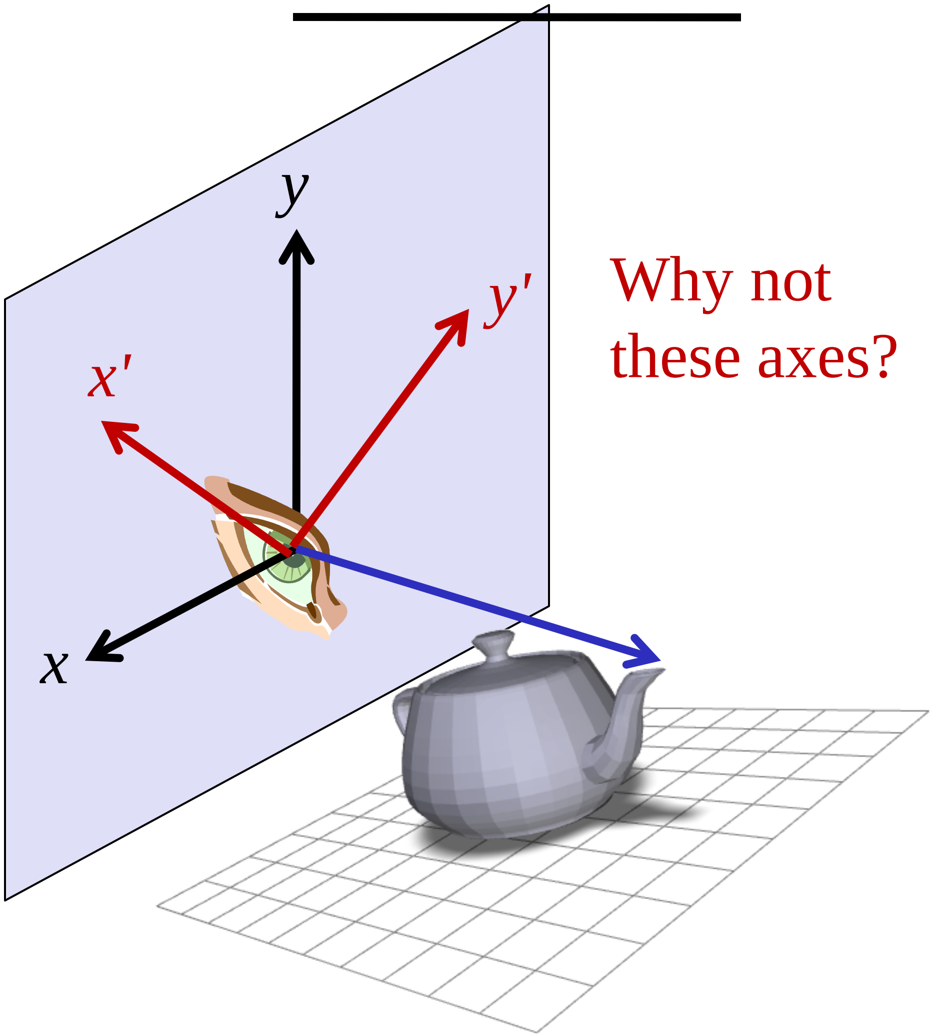
Viewing Coordinates



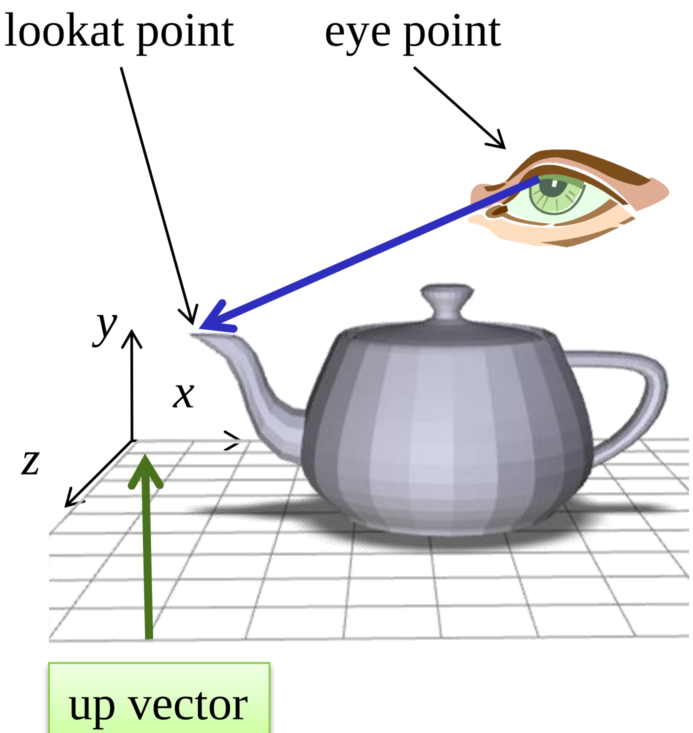
World Coordinates



Viewing Coordinates

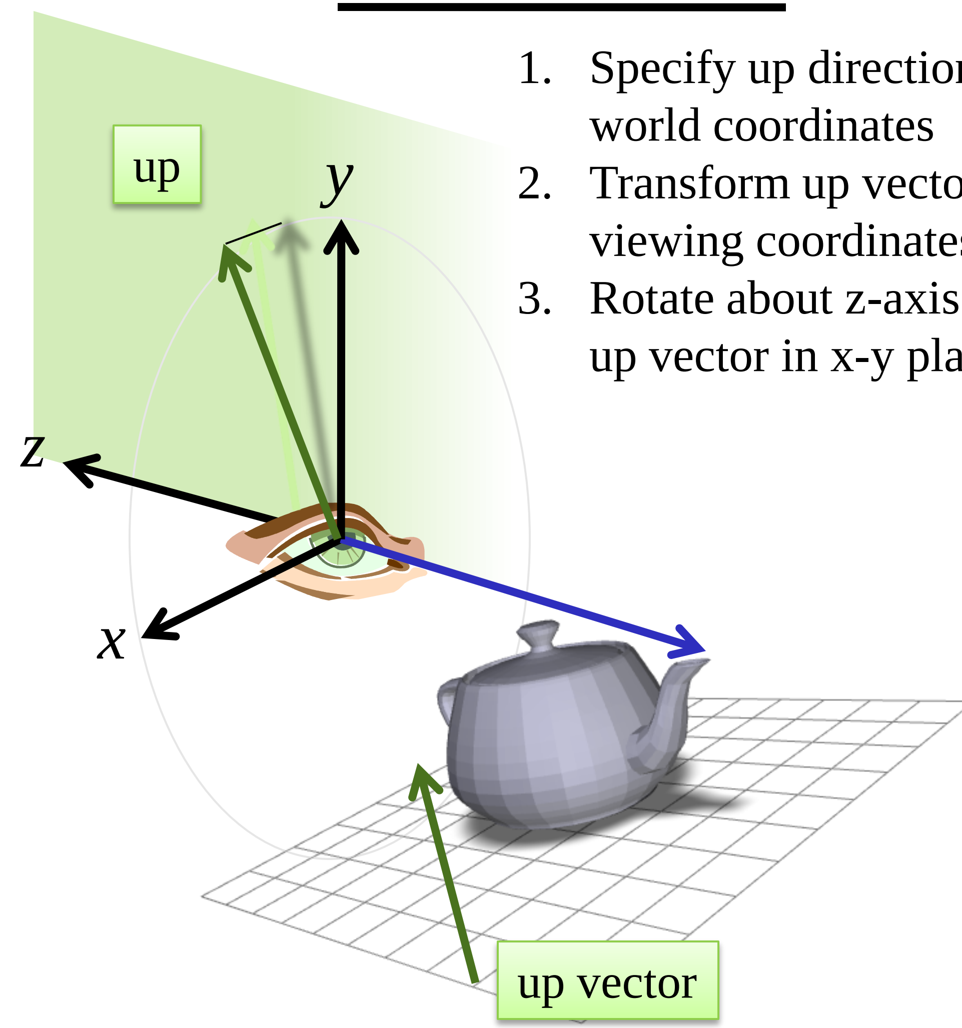


World Coordinates

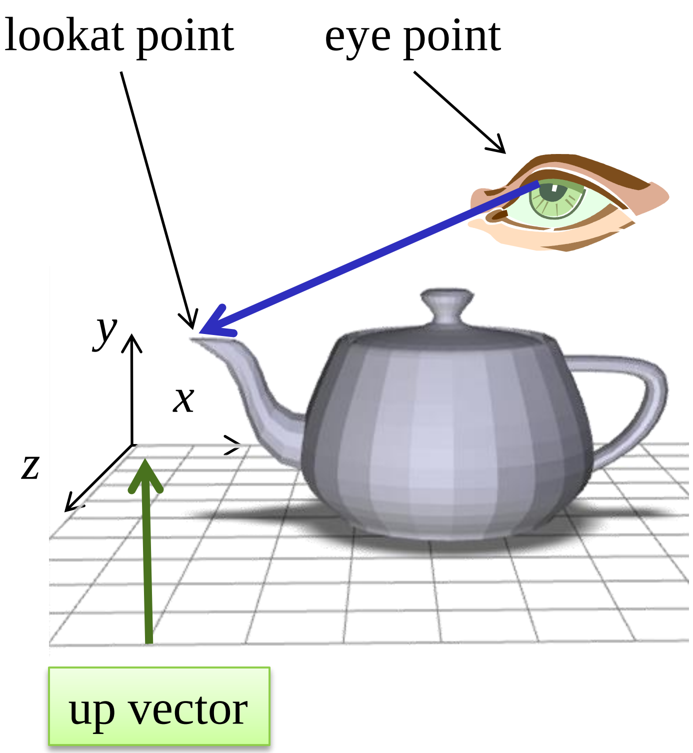


Viewing Coordinates

1. Specify up direction in world coordinates
2. Transform up vector into viewing coordinates
3. Rotate about z-axis until up vector in x-y plane.



World Coordinates



Viewing Coordinates

1. Specify up direction in world coordinates
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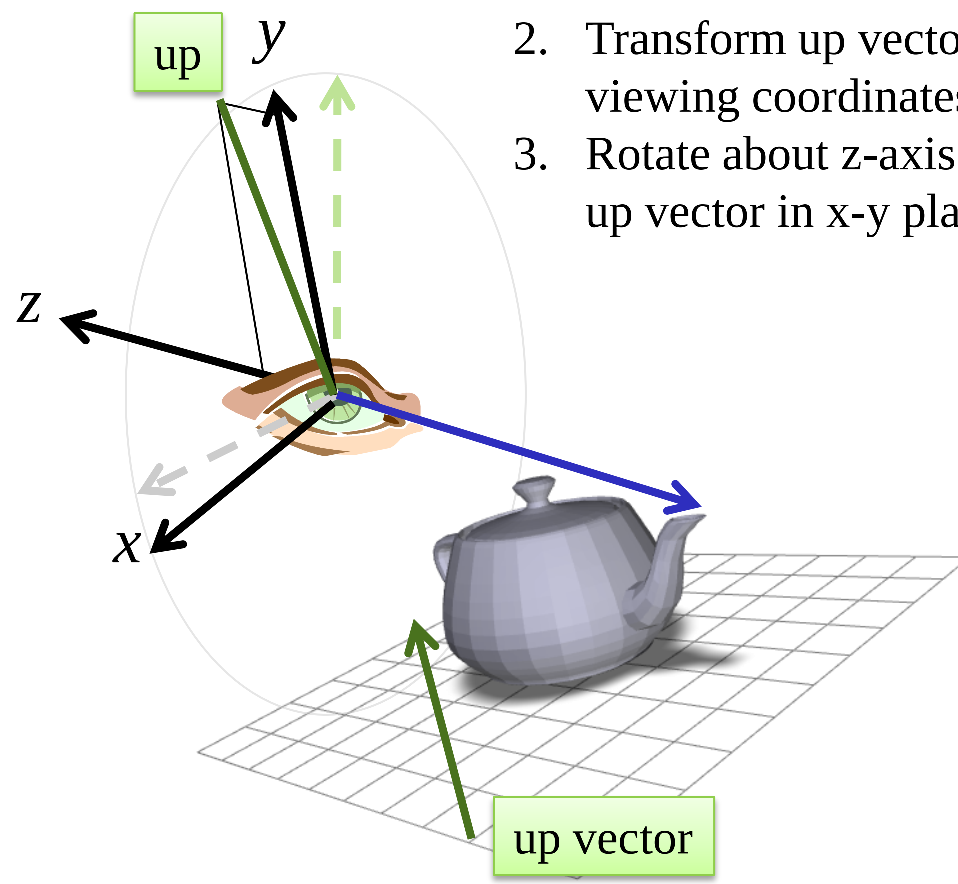
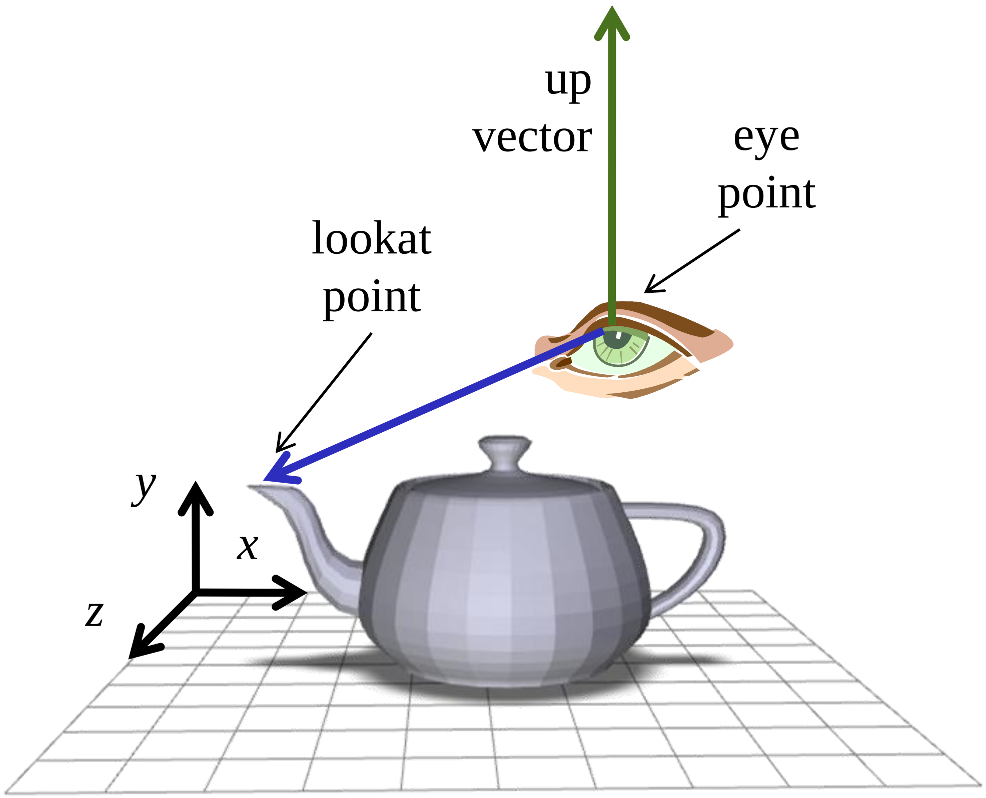
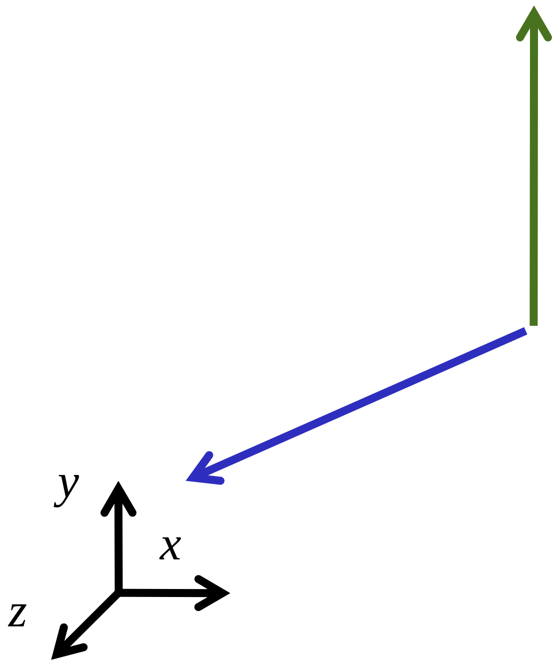


Lookat Transformation



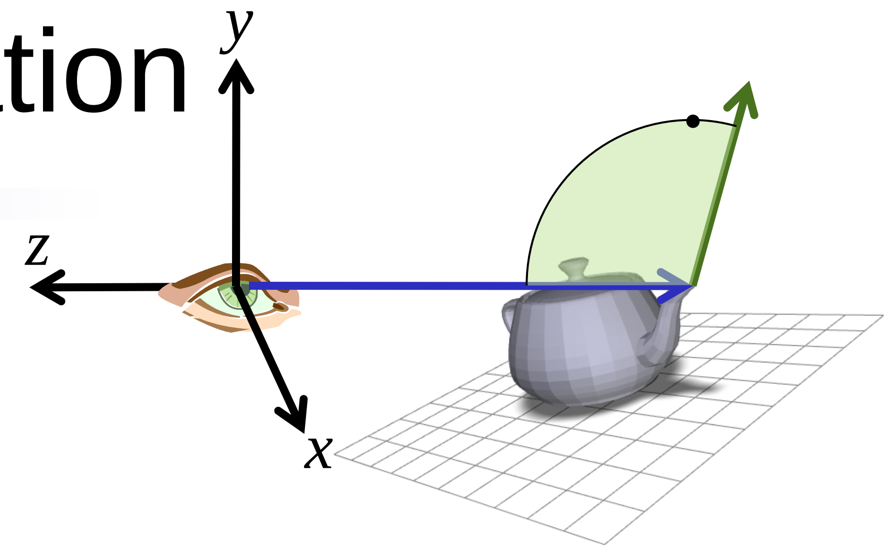
Lookat Transformation

1. Translate the eye point to the origin

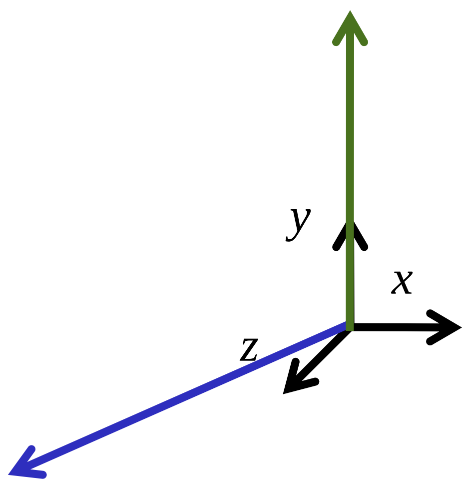


$$\begin{bmatrix} 1 & & & -x \\ & 1 & & -y \\ & & 1 & -z \\ & & & 1 \end{bmatrix}$$

Lookat Transformation



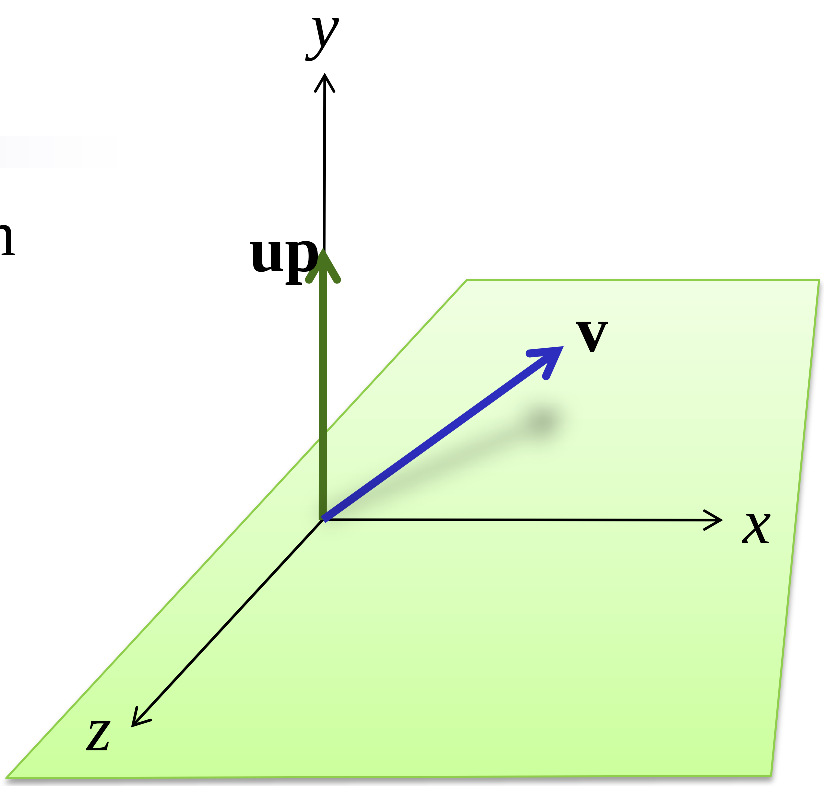
1. Translate the eye point to the origin
2. Rotate the view vector into the negative z-axis



$$\begin{bmatrix} & & & \\ & R & & \\ & & & \\ & & & \end{bmatrix}\begin{bmatrix} 1 & & & -x \\ & 1 & & -y \\ & & 1 & -z \\ & & & 1 \end{bmatrix}$$

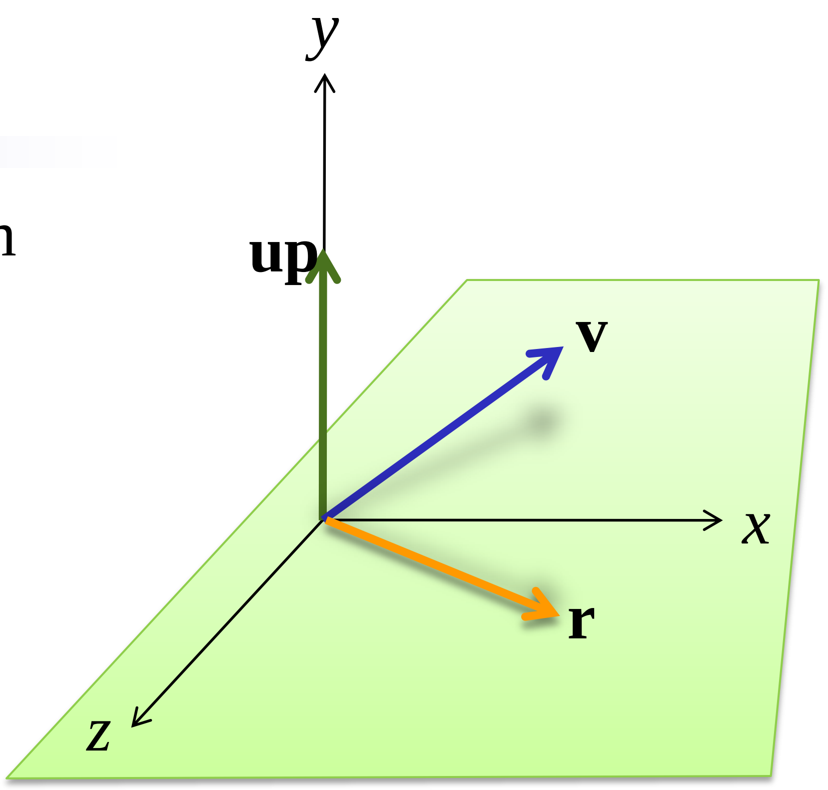
Easier Way

- Orthogonalize lookat vector system



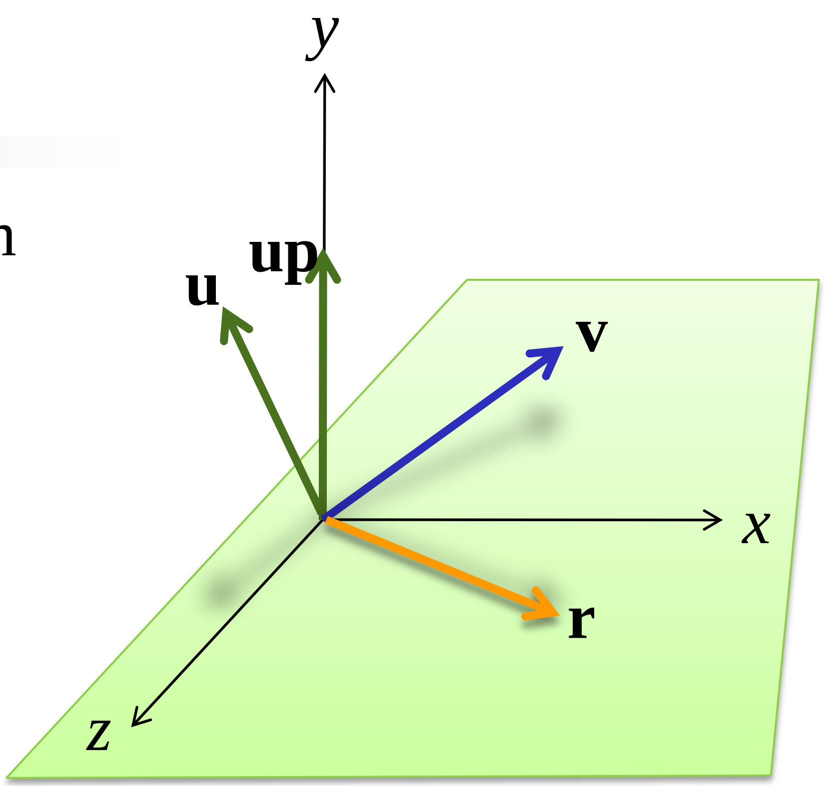
Easier Way

- Orthogonalize lookat vector system
  - Let $\mathbf{r} = \mathbf{v} \times \mathbf{up} / ||\mathbf{v} \times \mathbf{up}||$



Easier Way

- Orthogonalize lookat vector system
  - Let $\mathbf{r} = \mathbf{v} \times \mathbf{up}/||\mathbf{v}\times\mathbf{up}||$
  - Let $\mathbf{u} = \mathbf{r} \times \mathbf{v}$

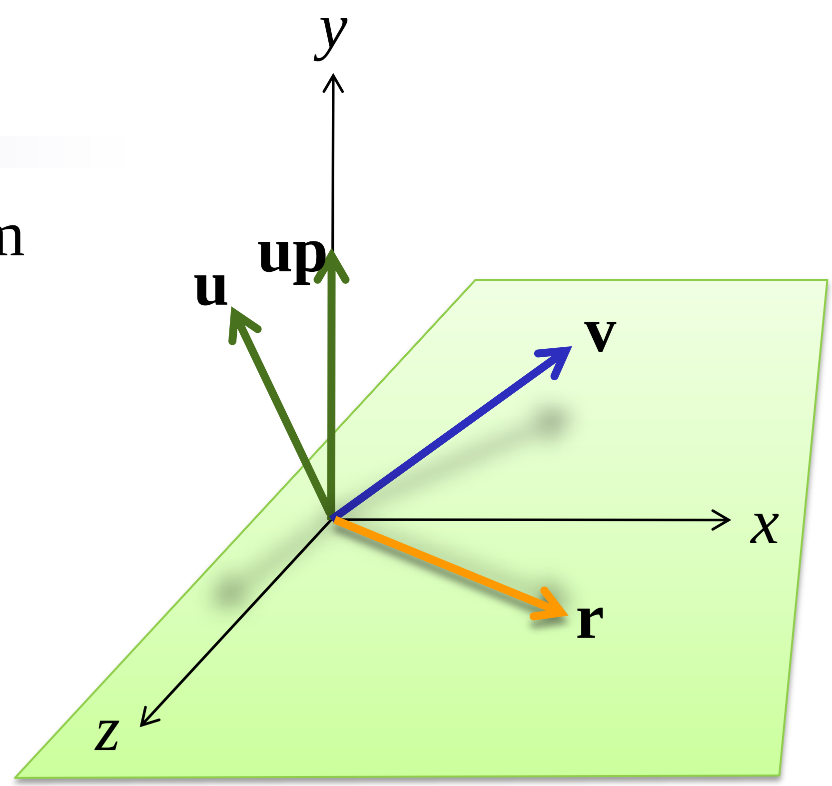


Easier Way

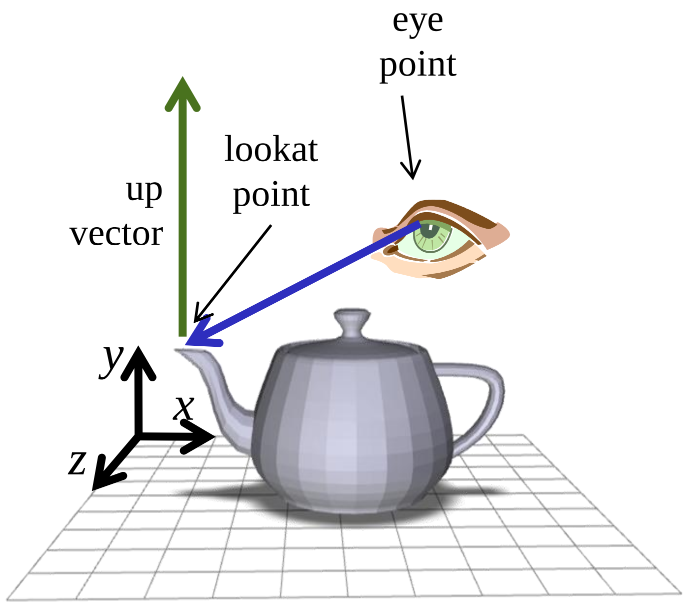
- Orthogonalize lookat vector system
  - Let **r** = **v** × **up**/||**v**×**up**||
  - Let **u** = **r** × **v**
  - Create rotation matrix from <**r**,**u**,**-v**> to <*x*,*y*,*z*>

$$R = \begin{bmatrix} \mathbf{r} & 0 \\ \mathbf{u} & 0 \\ -\mathbf{v} & 0 \\ & 1 \end{bmatrix}$$

R **r** = **x**, R **u** = **y**, R **v** = **-z**

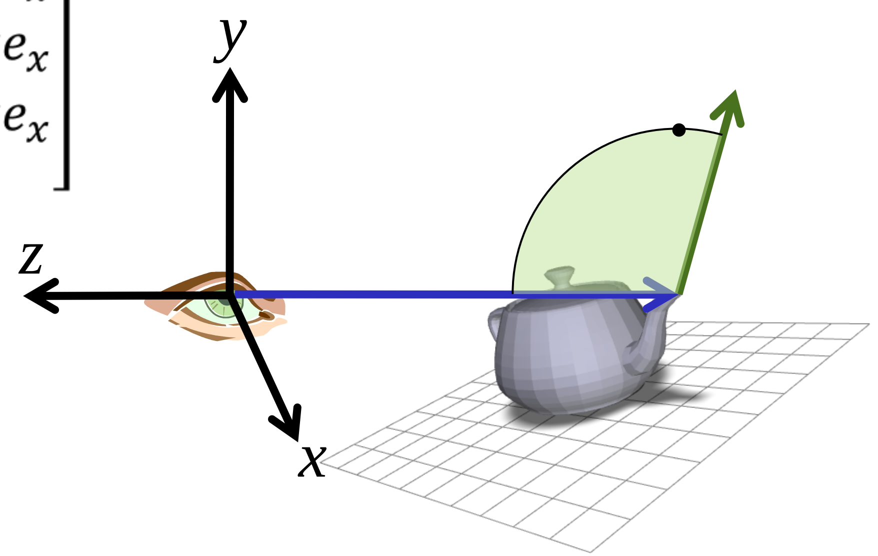


Construct Lookat



- Translate eye point to origin
- Rotate view into -z axis
  - Let **v** = (lookat - eye)/||lookat - eye||
  - Let **r** = **v** × **up**/||**v**×**up**||
  - Let **u** = **r** × **v**

$$\begin{bmatrix} r_x & r_y & r_z & \\ u_x & u_y & u_z & \\ -v_x & -v_y & -v_z & \\ & & & 1 \end{bmatrix} \begin{bmatrix} \mathbf{1} & & & -eye_x \\ & \mathbf{1} & & -eye_x \\ & & \mathbf{1} & -eye_x \\ & & & 1 \end{bmatrix}$$



Viewing Transformation