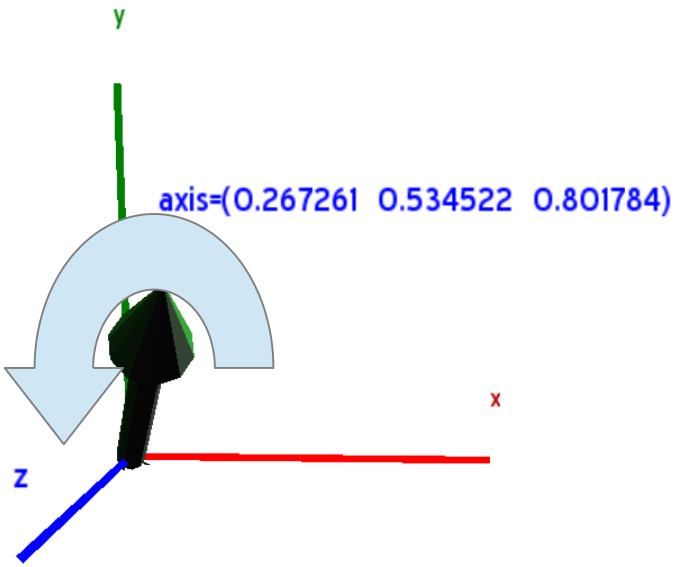
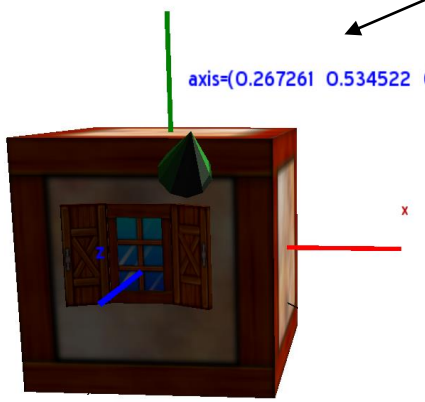
# Let's compute the rotation matrix R

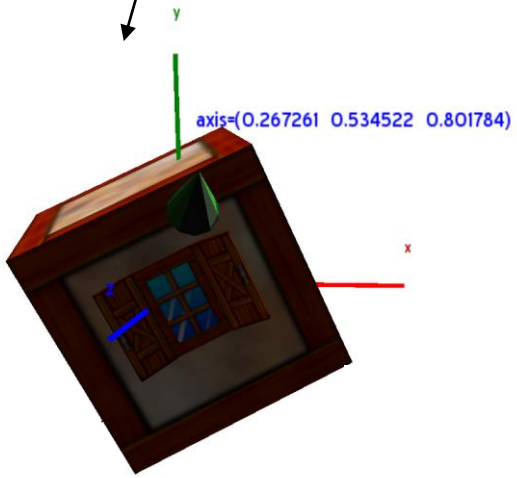
Rotation about $axis = (1,2,3)$ by $\theta = 30$ degrees



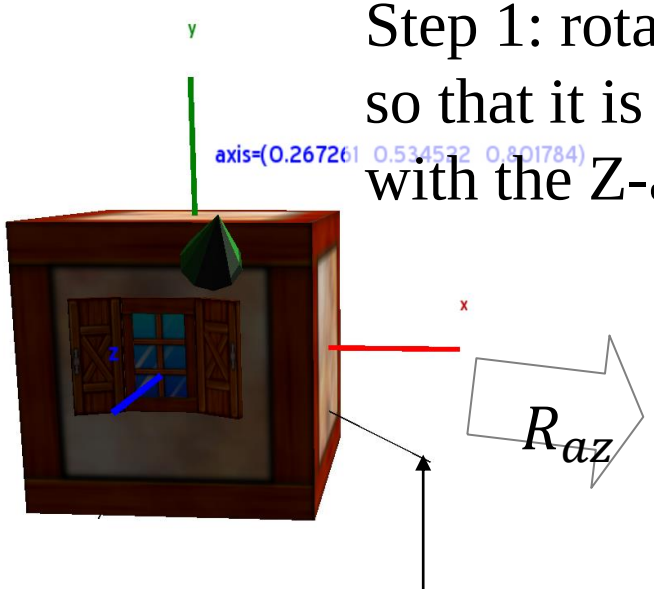

Before rotation




After rotation



Step 1: rotate the axis so that it is aligned with the Z-axis

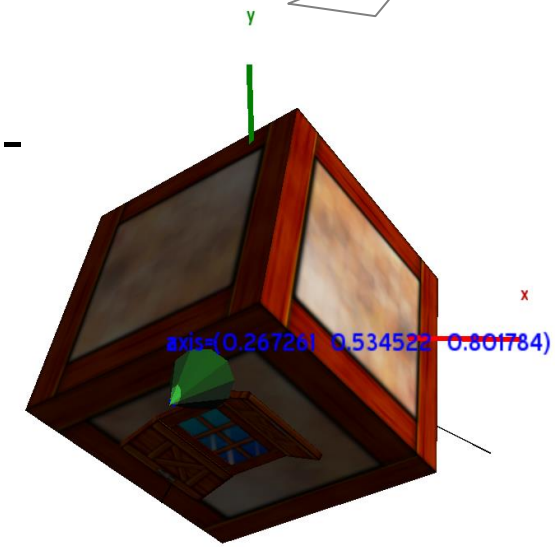



$R_{az}$

rotation axis of $R_{az}$

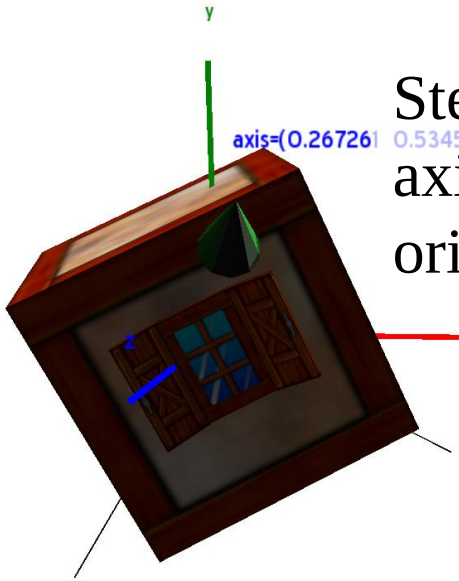

Step 2: rotate about the Z-axis by $\theta = 30$

$R_z$




Step 3: rotate the Z-axis back to the original axis

$R_{az}^{-1}$



# How to compute $R_{az}$ (Axis a to axis z)

1. Let the normalize axis

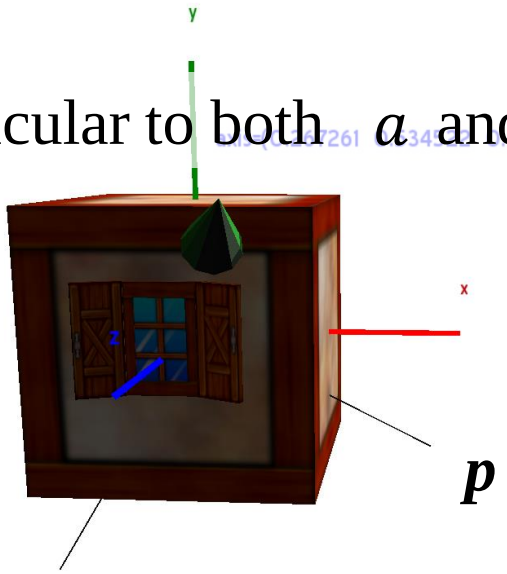
$$a = \frac{axis}{\|axis\|} \approx (0.27, 0.53, 0.80)$$

$$\|v\| = \sqrt{v \cdot v} = x^2 + y^2 + z^2$$

where $v = (x, y, z)$

2. Calculate vector $p$ that is perpendicular to both $a$ and Z-axis

$$p = \frac{a \times (0,0,1)}{\|a \times (0,0,1)\|}$$



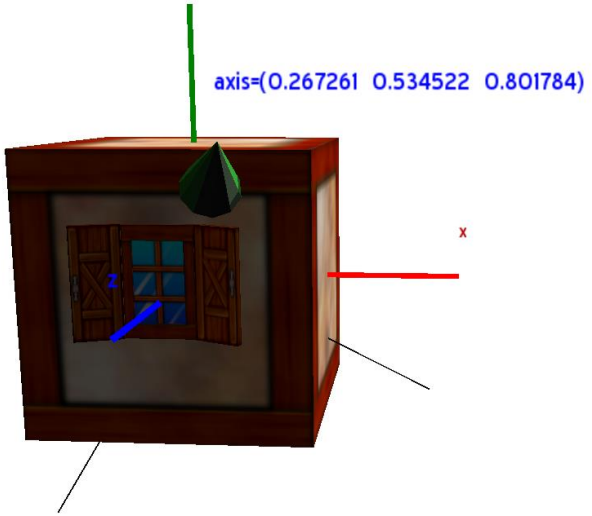
# How to compute $R_{az}$

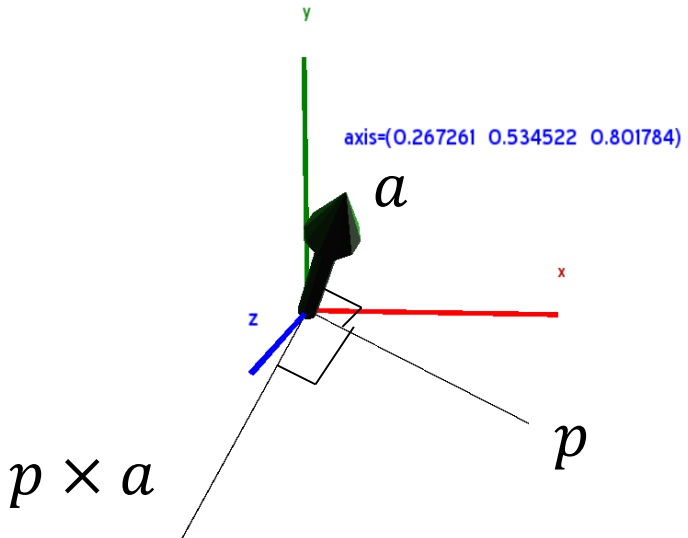
3. after rotation $R_{az}$

$R_{az}a$ becomes $(0,0,1)$

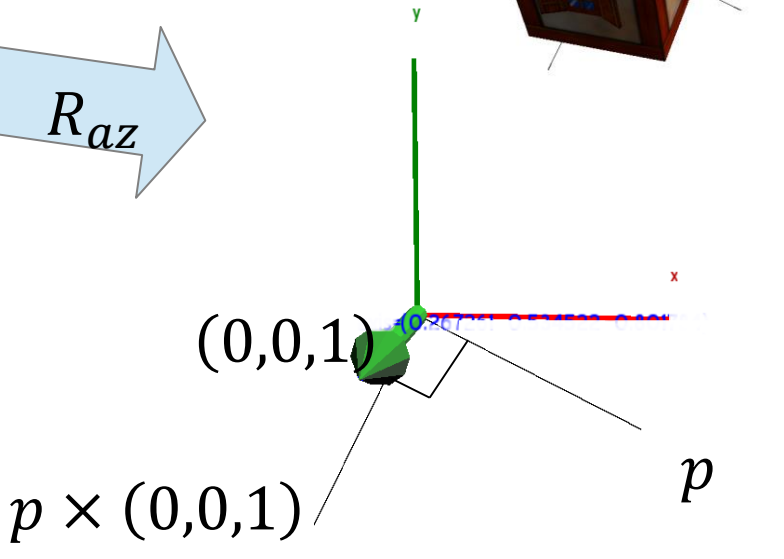
$R_{az}p$ becomes $p$

$R_{az}(p \times a)$ becomes $p \times (0,0,1)$




$R_{az}$



# How to compute $R_{az}$

3. Then after the rotation $R_{az}$

$$R_{az}a \quad \text{becomes} \quad (0,0,1)$$

$$R_{az}p \quad \text{becomes} \quad p$$

$$R_{az}(p \times a) \quad \text{becomes} \quad p \times (0,0,1)$$

Therefore,

$$R_{az}([a][p][p \times a]) = \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} \quad [p] \quad [p \times (0,0,1)]$$

Finally,

$$R_{az} = \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} \quad [p] \quad [p \times (0,0,1)] \Big) ([a][p][p \times a])^{-1}$$

Matlab codes:

```
> z=[0;0;1]
> Raz=[z p cross(p,z)] *inv([a p cross(p,a)])
```

# Finally,

- **The rotation matrix** $R = R_{az}^{-1} R_z R_{az}$