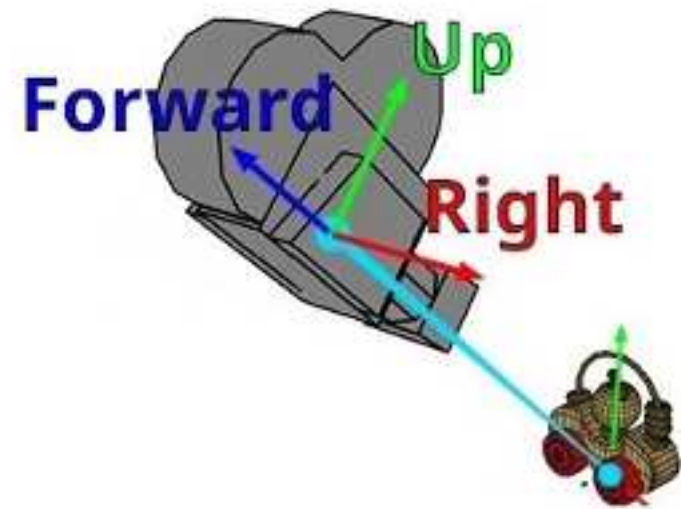# Orientation Representation

One might imagine these would be in degrees/rads ?

But it is useful to represent them with vectors !

One each for:

"Up", "Right" and "Forward"

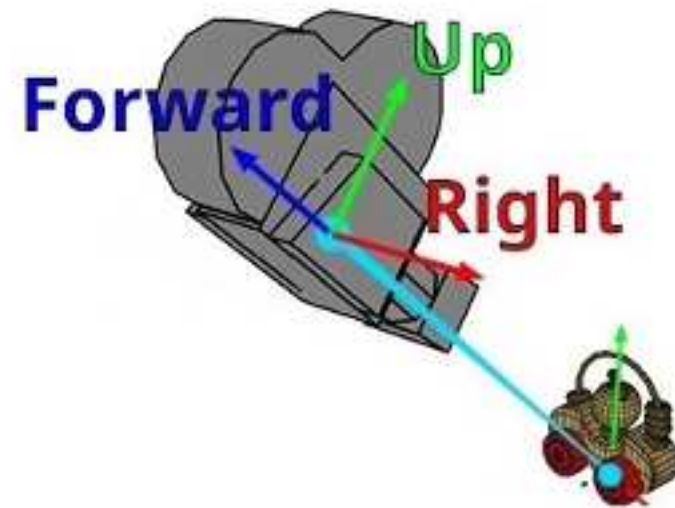Sometimes inverses are used:

"Down", "Left" and "Back"

Suggested Matrix Packing

Camera orientation is typically stored in a matrix:

$$
\begin{array}{c}
\\
x \\
y \\
z
\end{array}
\begin{array}{ccc}
\text{Right} & \text{Up} & \text{Forward} \\
? & ? & ? \\
? & ? & ? \\
? & ? & ?
\end{array}
$$

Each column is a vector
that indicates the direction
of one aspect of the camera

Applying Camera Orientation

When rendering we must incorporate orientation
If we turn the camera away from an artefact
Its position on the image plan will obviously shift

We first calculate vector from camera pos to artefact
Then multiply this vector by the orientation matrix

This results in a corrected vector giving the direction
of the artefact w.r.t. the camera orientation

Applying Camera Orientation in Code

Say the direction of a vertex from camera position is:

```
vec3 cameraToVertex = vec3(3,4,5);
```

And the current camera orientation is:

```
mat3 cameraOrientation;
```

We adjust the direction vector with orientation
Luckily we can use standard mathematical operators:

```
adjustedVector = cameraToVertex * cameraOrientation;
```

Updating Camera Orientation

Changing the camera orientation is simple
We just apply the normal rotation matrices

For example, to tilt the camera (about X) we do:

```
mat3 rotationMatrix(vec3(1.0, 0.0, 0.0),
                    vec3(0.0, cos(angle), sin(angle)),
                    vec3(0.0, -sin(angle), cos(angle)));


cameraOrientation = rotationMatrix * cameraOrientation;
```
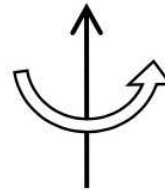
Just Use the Standard Rotation Matrices
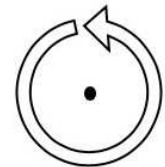
Rotation about X axis
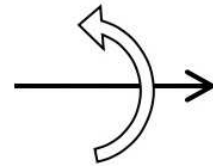
$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\theta & -\sin\theta \\ 0 & \sin\theta & \cos\theta \end{bmatrix}$$

Rotation about Y axis

$$\begin{bmatrix} \cos\theta & 0 & \sin\theta \\ 0 & 1 & 0 \\ -\sin\theta & 0 & \cos\theta \end{bmatrix}$$

Rotation about Z axis

$$\begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$