Using \( L^{-1} \) is like bringing somebody to a photography studio.

original objects.

transformed objects is the SAME as the custom camera picture of the

between the objects and the camera so the standard picture of the

OpenGl standard camera. \( L \) transforms objects and your custom camera into objects and the

Suppose you want a picture taken with a differently shaped, directed and

MINUS ZEE) axes and takes a fixed, standard picture.

OpenGl defines a FIXED STANDARD "camera" looks toward the –

The OpenGl Camera.
the computer do a transformation that reflects objects across this line?
and that line doesn’t necessarily go through the origin. How can you make
In the plane, suppose you are given an oblique line by means of two points,

\[ \text{Kind of problem this topic will help solve:} \]

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\[ \Lambda \cdot \Lambda^\top = \| \Lambda \| \]

So, the 3-d version of the Pythagorean Theorem is:

\[ \| \Lambda \| = (\Lambda \Lambda^\top)_{\text{length}} = \| \mathbf{z} \| + \| \mathbf{h} \| + \| \mathbf{x} \| = \Lambda \cdot \Lambda \cdot \begin{bmatrix} \mathbf{z} \\ \mathbf{h} \\ \mathbf{x} \end{bmatrix} = \Lambda \cdot \Lambda \cdot \begin{bmatrix} \mathbf{z} \\ \mathbf{h} \\ \mathbf{x} \end{bmatrix} \]

So, when

\[ \mathbf{h} \mathbf{h} + \mathbf{z} \mathbf{x} \mathbf{x} \mathbf{x} = \begin{bmatrix} \mathbf{z} \\ \mathbf{h} \\ \mathbf{x} \end{bmatrix} \begin{bmatrix} \mathbf{z} \\ \mathbf{h} \\ \mathbf{x} \end{bmatrix} \]

: Dot product algebraically (and computationally):

Dot product and cosines.
\[
(\text{cosine of angle between } \mathbf{w} \text{ and } \mathbf{v}) \| \mathbf{w} \| \| \mathbf{v} \| = \mathbf{w} \cdot \mathbf{v}
\]

Geometrically,
Ordinary coordinate unit vectors are mutually orthogonal
and length 1 or normal also, so they are orthonormal.
The same is true in 3-d.

\[
\begin{bmatrix}
1 & 0 \\
0 & 1
\end{bmatrix}
\begin{bmatrix}
\Theta \cos
\Theta \sin \\
\Theta \sin \\
\Theta \cos
\end{bmatrix}
= \\
\begin{bmatrix}
\Theta \cos & \Theta \sin \\
\Theta \sin & \Theta \cos
\end{bmatrix}
\begin{bmatrix}
\Theta \cos & \Theta \sin \\
\Theta \sin & \Theta \cos
\end{bmatrix}
\begin{bmatrix}
\Theta \cos & \Theta \sin \\
\Theta \sin & \Theta \cos
\end{bmatrix}
\end{align*}

This makes it easy to figure out the inverse of \( R^\theta \).

\[
I = \Theta \cos^2 + \Theta \sin^2 = \Theta \cos^2 + \Theta \sin(\Theta \sin -)
\]

\[
= \begin{bmatrix}
\Theta \cos & \Theta \sin \\
\Theta \sin & \Theta \cos
\end{bmatrix}
\begin{bmatrix}
\Theta \cos & \Theta \sin \\
\Theta \sin & \Theta \cos
\end{bmatrix}
= \begin{bmatrix}
\Theta \cos & \Theta \sin \\
\Theta \sin & \Theta \cos
\end{bmatrix}
\begin{bmatrix}
\Theta \cos & \Theta \sin \\
\Theta \sin & \Theta \cos
\end{bmatrix}
\]

They are also orthonormal after rotation: Consider rotated.
respecitively.

\[ \begin{bmatrix} x_1 \\ y_1 \\ z_1 \end{bmatrix} \]

Each column is the coefficients of a unit vector \( \mathbf{w} \), whose are the cosines of the angles \( \mathbf{w} \) makes with the \( x \)-axis, \( y \)-axis and \( z \)-axis.

\[ I = \begin{bmatrix} z_3 & z_3 & z_3 \\ y_3 & y_2 & y_1 \\ x_3 & x_2 & x_1 \end{bmatrix} \]

(The same is true for 3-D rotation matrices built out of direction cosines.)
in the other order.
it ends up. Then, starting with same initial position, try the same rotations
object 90° around the x – axis, and then 90° around the y – axis, see how

eyward please TRY THIS. Define axes by drawing lines on paper and
Also, only in 2-d to successive rotations commute. In 3-d \( R^x R^y \neq R^y R^x \).

For example, it's false for transformations with homogeneous coordinates.

equal the transpose

only for very special matrices does the inverse
the computer do a transformation that reflects objects across this line? and that line doesn’t necessarily go through the origin. How can you make a line through two points, in the plane, suppose you are given an oblique line by means of two points,
3. Express x-axis reflection by a matrix.

It's a mystery how to build it, to solve later.

2. Form $R^\Theta$ that rotates the x-axis into the direction of our reflection

\[
\begin{bmatrix}
1 & 0 & 0 \\
0 & 1 & -1 \\
1 & 0 & 1
\end{bmatrix}
= (I_{1,2})_1 \begin{bmatrix}
1 & 0 & 0 \\
2 & 1 & 0 \\
1 & 0 & 1
\end{bmatrix} = (I_{1,2})_2 L
\]

1. Form $L(I_{1,2})$ that translates the origin to (1, 2):

Move the x-axis into the oblique line. Detailed steps:

Strategy idea: Reflection through the x-axis is easy. Use $x' = x$ and use $x = x'$. We can conjugate x-axis reflection with transformations that
Please analyze the geometric meaning of the 5 transformations composed to form the Answer.

\[ \Theta \]

\[ (1, 2) \]

\[ (9, 5) \]

\[ \Theta \]

\[ (1, 2) \]

\[ \text{Answer} \]

4. Put it together:
\[
\begin{bmatrix}
1 \\
0 \\
0
\end{bmatrix} \hat{\mathbf{e}} \bigcup \begin{bmatrix}
\mathbf{x} \\
\mathbf{x}
\end{bmatrix} = \Theta \mathbf{R}
\]

and \( \mathbf{R}^{-1} \) is \( \mathbf{R} \).

3. Answers:

2. Rotate \( \mathbf{U} \) \( 90^\circ \) CCW to form \( \mathbf{U} \).

(We leave this as a subproblem.)

3. (8, 3) = (z - \( 1, 5 - 6 \)) = (\hat{\mathbf{e}} \times \mathbf{x}) \times \mathbf{x}

1. Form a unit vector \( \mathbf{U} \) in the direction of our reflection line. That direction is the direction of \( \mathbf{x} \). \( \mathbf{U} \).

Now, let's solve the mystery.
\[
\begin{bmatrix}
\frac{\varepsilon \wedge}{\varepsilon} \\
\varepsilon \wedge \\
\frac{\varepsilon \wedge}{\varepsilon}
\end{bmatrix}
= \begin{bmatrix}
\varepsilon \\
\varepsilon \\
1
\end{bmatrix}
\frac{\varepsilon \wedge}{\varepsilon}
= x \Omega
\]

So,

\[
\varepsilon \wedge = 6 + \varepsilon_6 \wedge = \varepsilon(\varepsilon) + \varepsilon(8) \wedge = \varepsilon(2 - 2) + \varepsilon(1 - 6) \wedge = \\
\varepsilon(\tilde{h} \nabla) + \varepsilon(x \nabla) \wedge = \left\| (\tilde{h} \nabla \left\|^x \nabla \right) \right\| = (\tilde{h} \nabla \left\|^x \nabla \right) \text{ length of vector } \nabla \text{ in the direction of our}
\]

\[
\left\| (\tilde{h} \nabla \left\|^x \nabla \right) \right\| = (\tilde{h} \nabla \left\|^x \nabla \right) \text{ that direction is the direction of vector } \nabla \text{ in the direction of our}
\]

\[
\left\| (\tilde{h} \nabla \left\|^x \nabla \right) \right\| = (\tilde{h} \nabla \left\|^x \nabla \right) \text{ in the direction of our}
\]

Now the submystery: Form a unit vector } x \Omega
\[
\begin{bmatrix}
\frac{3 \pi / 8}{\varepsilon} \\
\frac{3 \pi / 8}{\varepsilon} - 1
\end{bmatrix} = \mathcal{N} \bigg\| \mathcal{N} \bigg\| = \mathcal{N} \bigg\|
\]
\[
\begin{bmatrix}
1 & 0 & 0 \\
0 & \frac{\zeta^\wedge}{8} & \frac{\zeta^\wedge}{3} \\
0 & \frac{\zeta^\wedge}{3} & \frac{\zeta^\wedge}{8}
\end{bmatrix}
= \Theta R^{-1}
\]

and

\[
\begin{bmatrix}
1 & 0 & 0 \\
0 & \frac{\zeta^\wedge}{8} & \frac{\zeta^\wedge}{3} \\
0 & \frac{\zeta^\wedge}{3} & \frac{\zeta^\wedge}{8}
\end{bmatrix}
= \Theta R
\]

Now that the submystery is solved, the solution to the mystery is:
Translate origin to $(1,2)$

(Translate $x$-axis back to translated line)

(Reflect)

(Translate translated line into $x$-axis)

(Translate $(1,2)$ to origin)

Putting it all together, Answer: $L = R^x_H \Theta L_{-1,1}^{(1,2)} \Theta H x R^1_{-1}$