Homogeneous Coordinates and their transformations
Announcements

- Assignment 1: sign up for grading. Link posted on Piazza
  http://doodle.com/dx74v4k87mtgrsdp
- Lateness policy: up to three days in the entire term
details will be posted on course web page
  Ensure you have submitted before your grading time slot
- Assignment 2 will be out this weekend
8 Translations of points

\[ \mathbf{p} \xrightarrow{\text{transf.}} \mathbf{p} + \mathbf{t} \]

\[ \mathbf{q} = \mathbf{p} + \mathbf{t} \]

\[ \begin{bmatrix} 1 & t_1 \\ 1 & t_2 \\ 1 & t_3 \end{bmatrix} \begin{bmatrix} p_1 \\ p_2 \\ p_3 \end{bmatrix} = \begin{bmatrix} p_1 + t_1 \\ p_2 + t_2 \\ p_3 + t_3 \end{bmatrix} = \mathbf{q} \]

So a translation is a linear transform in homogeneous coordinates!! So a 4×4 matrix.
Already know that rotations, scaling are also 4x4 matrices.

So all common manipulations are 4x4 matrices.

This is why these are in the DNA of OpenGL.

8 Special cases

Rotation

\[
\begin{bmatrix}
R & 0 \\
0 & 1
\end{bmatrix}
\]

Rotates its "input" about the origin of the frame.

Scaling

\[
\begin{bmatrix}
s_1 & 0 & 0 \\
0 & s_2 & 0 \\
0 & 0 & s_3 \\
\end{bmatrix}
\]

Put it all together

\[
\begin{bmatrix}
l_{3x3} & t \\
l_{3x3} & t \\
\end{bmatrix}
\]
This is the general form of any affine transformation.
C³Homework: Basis and Transformation

- What are the coordinates of point P in frame A, B, and C?
- Which frame is orthonormal?
- How to transform a point from frame C to frame B?