

Homework #1

Matrices, Vectors, and Transforms

Due Thursday, September 13 by the end of class

Question #1: (20 points)

For each of the following homogeneous coordinates,

(a) (6 pts) state whether it is a point or a vector.

(b) (6 pts) state whether it is normalized or not.

(c) (8 pts) if it is not normalized, please normalize it; if it is already normalized, do nothing.

$$\begin{bmatrix} 1 \\ 5 \\ 9 \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} 11 \\ 8 \\ 6 \\ 4 \end{bmatrix}$$

$$\begin{bmatrix} 5 \\ 7 \\ 2 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 7 \\ 7 \\ 7 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 1/\sqrt{2} \\ 0 \\ 1/\sqrt{2} \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 14 \\ 7 \\ 21 \\ 1 \end{bmatrix}$$

Question #2: (15 points)

$$\begin{bmatrix} 2 \\ -1 \\ 5 \end{bmatrix} \cdot \begin{bmatrix} 3 \\ 8 \\ 10 \end{bmatrix} =$$

(a) (5 pts) Solve the following dot product:

$$\begin{bmatrix} 4 \\ 1 \\ 9 \end{bmatrix} \times \begin{bmatrix} 2 \\ 8 \\ 1 \end{bmatrix} =$$

(b) (5pts) Solve the following cross product:

(c) (5pts) State the equation for the plane defined by the vector $[1, 2, 3, 0]^T$ and the point $[3, 2, 1, 1]^T$. Your answer should be in the form $ax + by + cz + d = 0$.

Question #3: (35 points)

Part I:

Write out the following 4x4 matrices and label each with the following names:

- (4 pts) **T0**: Translate in x by 4 and in y by 3
- (4 pts) **R**: Rotate about the z axis by $\pi/4$ (45 degrees)
- (4 pts) **T1**: Translate in x by -4 and in y by -3
- (4 pts) **S**: Scale in x by a factor of 2, and y by a factor of 4 (z is unchanged)

Part II: (5 pts)

Assume you have an object you want to rotate by $\pi/4$ around a z-axis centered at (4,3,0). Using the symbols **T0**, **R**, and **T1**, please show the correct order of composition of those matrices to perform the desired rotation.

Part III: (10 pts)

Multiply out your answer from part II.

Part III: (8 pts)

Apply the transform **R** to the 3D coordinate (7, 5, 7) and multiply out.