

# CS251 HW 2 | Mon Feb 18, 2019 | Week 3

Name:

## Question 1

Assume that `matA` is a 3x3 Numpy matrix and `matB` is a 4x3 Numpy matrix.

Indicate whether the following operations are valid. If so, **specify the dimensions of the result.**

I suggest doing these by hand and only using a computer to check your answer.

a. `4000 / matB.T`

b. `matA * matB`

c. `matA - np.prod(matB, axis=0)`

d. `matA - np.prod(matB.T, axis=1)`

e. `matB + np.matrix([0, 0, 0, 0])`

f. `matB + np.matrix([1, 2, 3, 4]).T`

## Question 2

a) If the observer is looking at the point  $(100, 200, 0)$  from  $(100, 200, 1)$  and  $\vec{U} = (1, 0, 0)$ , what direction does the observer's upward axis point? *Specific numbers aren't required to get the correct answer. HINT: Write the relevant cross product equation then use your hand!*

b) If the following is the first translation matrix in the 3D viewing pipeline, what do the parameters mean? What does the matrix do in the pipeline?

$$T = \begin{pmatrix} 1 & 0 & 0 & -50 \\ 0 & 1 & 0 & -60 \\ 0 & 0 & 1 & -70 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

c) Write the scale matrix that would *in part* transform points in normalized view volume coordinates to screen coordinates (i.e. other matrices not asked about here are required to complete the coordinate transform). Assume the observer and viewer volume coordinate axes are currently aligned and that the target app window is 800 x 600 *px* (width x height).

*Important Note: Make sure you understand why all the signs are what the way that they are!!*

### Question 3

Consider the following scenario:

- The observer is positioned at  $(100, 100, -7)$
- The observer looks at  $(100, 100, 0)$
- The observer's upward axis is *initially* aligned with  $(0, 1, 0)^T$
- The data range in x is  $(0, 1)$ , the data range in y is  $(10, 20)$ , the data range in z is  $(-5, 5)$ .

a) Compute the observer coordinate system ( $V\vec{P}N$ ,  $\vec{U}$ , and  $V\vec{U}P$  vectors).

b) Express your answers from a) as normalized vectors.

c) Write the translation matrix that brings the observer to the view volume origin.

d) Write the matrix that aligns the observer and view volume axes.