CS-174A Discussion 1C, Week 2

@ Xiao (Steven) Zeng

@ Instructor: Dr. Asish Law

@ Discussion 1C Github: https://github.com/NoctisZ/CS174A-1C-2020Fall (https://github.com/NoctisZ/CS174A-1C-2020Fall)

Outline

- Mockup Midterm
- Review of Lecture Content
- Q&A about Assignment 2

Mockup Midterm

- Link under Midterm tab on CCLE: https://ccle.ucla.edu/course/view/20F-COMSCI174A-1?section=12 (https://ccle.ucla.edu/course/view/20F-COMSCI174A-1?section=12)
- Please follow the Online Exam Instructions: https://ccle.ucla.edu/pluginfile.php/3801882/mod_resource/content/0/CS174A%20Online%20Midte (https://ccle.ucla.edu/pluginfile.php/3801882/mod_resource/content/0/CS174A%20Online%20Midt
- Adjust your camera so that we can see your whole face (appropriate angle, good lighting, etc.)
- Write your name and student ID on each page
- Write down "I have read and acknowledge everything written on the last page of midterm titled "Academic Integrity: A Bruin's Code of Conduct"" before your signature on the last page if answering using blank papes

Review of Lecture Content

Homogeneous representation of points and vectors

- Vectors: $v = \beta_1 v_1 + \beta_2 v_2 + \beta_3 v_3$

$$\begin{aligned} v &= \beta_1 v_1 + \beta_2 v_2 + \beta_3 v_3 \\ &= \begin{bmatrix} \beta_1 & \beta_2 & \beta_3 & 0 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ P_0 \end{bmatrix} \end{aligned}$$

- Points: $P_1 = P_0 + \alpha_1 v_1 + \alpha_2 v_2 + \alpha_3 v_3$

$$P = [\alpha_1 \quad \alpha_2 \quad \alpha_3 \quad 1] \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ P_0 \end{bmatrix}$$

Operations on homogeneous representations

- $\mathbf{v} + \mathbf{w} = [v_1, v_2, v_3, 0]^T + [w_1, w_2, w_3, 0]^T$
  $= [v_1 + w_1,\ v_2 + w_2,\ v_3 + w_3,\ 0]^T$ Vector
- $a\mathbf{v} = a[v_1, v_2, v_3, 0]^T = [av_1,\ av_2,\ av_3,\ 0]^T$ Vector
- $a\mathbf{v} + b\mathbf{w} = a[v_1, v_2, v_3, 0]^T + b[w_1, w_2, w_3, 0]^T$
  $= [av_1 + bw_1,\ av_2 + bw_2,\ av_3 + bw_3,\ 0]^T$ Vector
- $P + \mathbf{v} = [p_1, p_2, p_3, 1]^T + [v_1, v_2, v_3, 0]^T$
  $= [p_1 + v_1,\ p_2 + v_2,\ p_3 + v_3,\ 1]^T$ Point
- $P - Q = [p_1, p_2, p_3, 1]^T - [q_1, q_2, q_3, 1]^T$
  $= [p_1 - q_1,\ p_2 - q_2,\ p_3 - q_3,\ 0]^T$ Vector

Basic Transformations

- Translation
- Scaling
- Rotation
- Shearing

- Translation

$$\begin{pmatrix} x' \\ y' \\ z' \\ 1 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & t_x \\ 0 & 1 & 0 & t_y \\ 0 & 0 & 1 & t_z \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \\ 1 \end{pmatrix}$$

- Scaling

$$\begin{pmatrix} x' \\ y' \\ z' \\ 1 \end{pmatrix} = \begin{pmatrix} s_x & 0 & 0 & 0 \\ 0 & s_y & 0 & 0 \\ 0 & 0 & s_z & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \\ 1 \end{pmatrix}$$

- Rotation
  Rotate about $z-$axis:

$$\begin{pmatrix} x' \\ y' \\ z' \\ 1 \end{pmatrix} = \begin{pmatrix} \cos(\theta) & -\sin(\theta) & 0 & 0 \\ \sin(\theta) & \cos(\theta) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \\ 1 \end{pmatrix}$$

- E.g. Rotation when $\theta = \pi/4$,

$$R = \begin{pmatrix} \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} & 0 & 0 \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

- Combination of transformation:
  Eg. Scale(2) first, then Translation(x = 1, y = 2, z = 3)

$$M_{translate} \cdot M_{scale} \cdot P_{original}$$

$$= \begin{pmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 2 \\ 0 & 0 & 1 & 3 \\ 0 & 0 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} x \\ y \\ z \\ 1 \end{pmatrix}$$

$$= \begin{pmatrix} 2 & 0 & 0 & 1 \\ 0 & 2 & 0 & 2 \\ 0 & 0 & 2 & 3 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \\ 1 \end{pmatrix} = \begin{pmatrix} 2x+1 \\ 2y+2 \\ 2z+3 \\ 1 \end{pmatrix}$$

Transformations are NOT commutative.

- Matrix multiplication is not commutative.
  - When performing multiple rotation transformations.
  - The order of transformation types matters.
  - i.e. $q = TRSTp$ is not the same as $q = TSRTp$

Q&A about Assignment 2

- Due on Oct. 25 at 11:59 PM
- Apply a series of transformations for part 3