

Sample Test 2a: Basic Objects, Coordinates

March 5, 2023

- State any simple, reasonable assumption used to arrive at your answer.
- A 'yes' or 'no' answer without reasoning is worth 0 points.
- Zero points if the writing is hard to decipher. Use a black pen if in doubt.
- Indicate with arrow if you use the back of the previous page (last page for page 1).

1 Polyhedra

- a. (2 points) Specify a regular octa-hedron in .off file format (=location + connectivity). Use integer coordinates. Illustrate with a clear drawing.

$\approx (1, 0, 0)$

oriented
Vertex

1	0	0
0	1	0
0	0	1
0	-1	0
-1	0	0
0	0	-1

1 2 3
2 4 3
7 more

- b. (1 points) Explain: What is the fewest number of triangle strips to cover the octa-hedron?

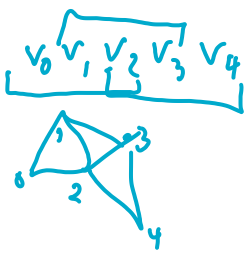
v_0, v_1, v_2

- c. (4 points) Specify the key operations to draw the octa-hedron using OpenGL (no exact OpenGL commands are needed).

VAO Indices

Bind
Buffer Data
glDrawElements
Unbind

VBO



2 Basic Operations on Coordinates

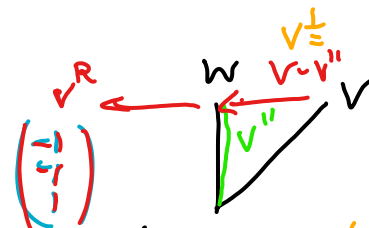
- a. (1 point) Compute the reflection of $\begin{bmatrix} 1 \\ 1 \end{bmatrix}$, across $\begin{bmatrix} 0 \\ 1 \end{bmatrix}$.

$$V^R = V - 2V^\perp \\ = V - 2V + 2\left(\frac{V \cdot W}{W \cdot W}\right)W$$

$$V'' = \frac{V \cdot W}{W \cdot W} W = \frac{1 \cdot 1}{1 \cdot 1} W = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$$

$$V^R = V - 2V'' = \begin{pmatrix} 1 \\ 1 \end{pmatrix} - 2 \begin{pmatrix} 0 \\ 1 \end{pmatrix} = \begin{pmatrix} 1 \\ -1 \end{pmatrix}$$

$$V^\perp = \begin{pmatrix} 1 \\ 1 \end{pmatrix} - \begin{pmatrix} 0 \\ 1 \end{pmatrix} = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$$



- b. (2 points) Define a 4×4 translation matrix T_1 , a rotation matrix R and a second translation matrix T_2 that map the line segment $\begin{bmatrix} 1 \\ 0 \end{bmatrix} \begin{bmatrix} 2 \\ 0 \end{bmatrix}$ to the line segment $\begin{bmatrix} 1 \\ 0 \end{bmatrix} \begin{bmatrix} q \\ 0 \end{bmatrix}$ of equal length. Clearly indicate your reasoning! What is q ?

$$C = \frac{\sqrt{2}}{2} = 0.5$$

$$T_2 = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$R = \begin{pmatrix} c & -s & 0 & 0 \\ s & c & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$T_1 = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 1 \\ 0 \\ 0 \\ 0 \end{pmatrix} = \begin{pmatrix} 1 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

- c. (1 point) A color (pink) has the Hue Saturation Intensity values (red, 0.5, 0.5). What are the values (coordinates) in RGB color space?