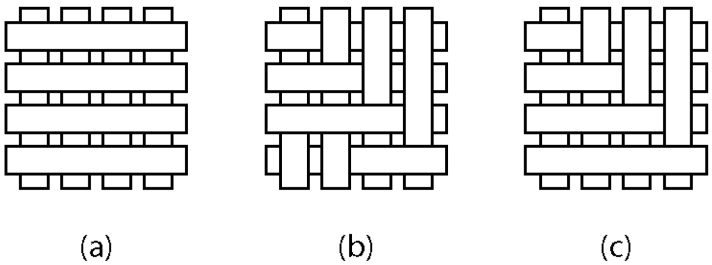
CS 464 Practice Exam

Problem 1 (15 pts): Which of the following scenes would cause problems for the Painter's Algorithm?



(These drawings are in image space; each rectangle is a single primitive.)

Problem 2: Transformations (15 pts)

Consider the following classes of elementary 3D transformations:

- scale(s_x, s_y, s_z)
- rotate-x(θ) — rotate about x axis counterclockwise by θ
- rotate-y(θ)
- rotate-z(θ)
- translate(t_x, t_y, t_z)

Each of the following sequences of transformations happens to reduce to a single transformation from one of these classes. Find the equivalent elementary transformation for each sequence.

1. scale(2, 1, 1), then scale(1, 3, 4)
2. scale(2, 1, 1), then rotate-y(90°), then scale(3, 1, 1), then rotate-y(-90°)
3. rotate-x(90°), then rotate-y(90°), then rotate-z(90°)
4. rotate-z(90°), then translate(1, 0, 0), then rotate-z(-90°)

Problem 3: Transformations (15 pts)

The matrices

$$\begin{bmatrix} 1 & -1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 0 & 0 & \sqrt{2} & 0 \\ 0 & 0 & 0 & \sqrt{2} \end{bmatrix}, \quad \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \text{ and } \begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

are a rotation by $+45^\circ$ about an axis through the origin in the direction $(0, 0, 1)$, a nonuniform scale by 2 about the origin along the direction $(0, 1, 0)$, and a reflection across the plane $x = 0$, respectively. Using the same forms of description, describe what the following products of matrices do:

1. $$\begin{bmatrix} 1 & 0 & 0 & -1 \\ 0 & 1 & 0 & -2 \\ 0 & 0 & 1 & -3 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & -\sqrt{3} & 0 \\ 0 & 2 & 0 & 0 \\ \sqrt{3} & 0 & 1 & 0 \\ 0 & 0 & 0 & 2 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 2 \\ 0 & 0 & 1 & 3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

2. $$\begin{bmatrix} 1 & -1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 2 \end{bmatrix} \begin{bmatrix} 1 & 1 & 0 & 0 \\ -1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Hint: That last one is a little tricky.

Problem 4: Triangle Meshes (10 pts)

Consider the indexed triangle set defined by

- vertex list [(–1, –1, –1) (–1, –1, 1) (1, –1,1) (1, –1, –1) (0, 1, 0)]
- and the Triangle indices [0 2 1, 0 2 3, 0 2 4, 4 0 1, 4 1 2, 4 2 3, 4 3 0].

1. Draw the shape described?
2. How could you do this as a triangle strip – just a single series of vertices in the indices list.

Problem 5: Triangle meshes (10 points)

The following indexed triangle set has a problem with it. What is the problem, and how can you tell? Remember: The order of triangles must be consistent in terms of Clockwise or counterclockwise.

vertices		triangles	
0	(0, 0, 0)	0	(0, 2, 1)
1	(1, 0, 0)	1	(1, 2, 3)
2	(0, 1, 0)	2	(0, 3, 2)
3	(0, 0, 1)	3	(1, 0, 3)

Problem 6: Matrix classification (10 points)

Classify each of the following 2D homogeneous matrices as follows: (a) rotation, (b) mirror reflection, (c) uniform scale, (d) nonuniform scale, (e) translation, (f) shear, or (g) combination.

Earlier categories take precedence over later categories if more than one applies. There is not a one-to-one mapping between the matrices and the categories.

1. $\begin{bmatrix} 1 & -1 & 0 \\ 1 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

2. $\begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

3. $\begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

4. $\begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

5. $\begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

6. $\begin{bmatrix} 2 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

7. $\begin{bmatrix} 1 & -1 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

Problem 7: Shading (10 pts)
Given a triangle mesh, briefly explain the key differences in how triangle normals are used to evaluate (i)
flat shading, (ii) Gouraud shading, and (iii) Phong shading.