

NAME:

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## Computer Science 426 Exam 2

### 13 Dec 2001

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This test is 8 questions, of equal weight. Do all of your work on these pages (use the back for scratch space), giving the answer in the space provided. This is a closed-book exam -- you may use one-page of notes with writing on both sides during the exam. **Put your name on every page, and write out and sign the Honor Code pledge before turning in the test.**

*"I pledge my honor that I have not violated the Honor Code during this examination."*

Question	Score
1	
2	
3	
4	
5	
6	
7	
8	
Total:	

NAME:

## Q1: Object Representations

(a) What is the typical object representation that people use to store medical scans of the human body, such as CT or MRI? (*a term or short description*)

(b) What does "2-manifold" mean when referring to triangular meshes? (*one sentence*)

(c) In a large triangular mesh (without very many holes), what is the ratio of the number of faces to number of vertices? (*a number and possibly a short explanation*)

(d) Assign ranks the following representations according to accuracy.  
*Write a number in each box, where 1=lowest accuracy and 4=highest.*

piecewise low-order polynomial

voxels

piecewise linear

implicit representation

(e) Rank these again, according to file size needed to represent a particular object.  
*Write a number in each box, where 1=lowest accuracy and 4=highest.*

piecewise low-order polynomial

voxels

piecewise linear

implicit representation

## Q2: Splines and Subdivision

(a) In Catmull-Clark subdivision, what is an “irregular vertex”? (*short description*)

(b) State two advantages of splines (piecewise low-order Beziers) over high-order Bezier curves.

(c) What is the “convex hull property” and why is it important? (*two sentences*)

(d) Mark with an X which of these curve and surface representations have the convex hull property:

Bezier curves

Catmull-Clark subdivision surfaces

Catmull-Rom splines

B-splines

### Q3: Continuity

(a) What are the meanings of each of the following forms of continuity:

$C^0$ :

$C^1$ :

$C^2$ :

$C^\infty$ :

(b) Ahead of each type of point, mark what kind of continuity it has (none,  $C^0$ ,  $C^1$ ,  $C^2$ ,  $C^3$ ,  $C^\infty$ ).

\_\_\_ The limit position of an irregular vertex after Loop subdivision.

\_\_\_ The limit position of an regular vertex after Loop subdivision.

\_\_\_ An interior point of a Bezier curve.

\_\_\_ A non-joint point on a uniform cubic B-spline.

\_\_\_ A joint of a uniform cubic B-spline.

\_\_\_ A joint of a cubic Catmull-Rom spline.

(c) For each statement, mark 1 for true, 0 for false (a little computer science humor ;-)

\_\_\_ Standard Loop subdivision cannot generate creases.

\_\_\_ Standard Loop subdivision does not work for meshes with holes.

\_\_\_ Standard Loop subdivision does not work for non-manifold meshes.

\_\_\_ Standard Loop subdivision preserves topology

\_\_\_ Catmull-Clark subdivision is an interpolating scheme.

\_\_\_ The limit location of a vertex can be computed directly (without iterated subdivision).

## Q4: Animation

(a) One principle of traditional animation is called “squash and stretch.” Name and describe three more principles. (*one sentence for each*)

i.

ii.

iii.

(b) Describe a problem with using linear interpolation between keyframes.

(c) Describe a problem with using interpolating splines between keyframes.

(d) What is the basic difference between dynamics and kinematics?

(e) What is the basic difference between forward kinematics and inverse kinematics?

(f) Where did the word *cel* in “cel animation” come from?

## Q5: NPR

(a) State three good reasons why one might prefer to use NPR rather than photorealistic imagery.

i.

ii.

iii.

(b) Why were Salisbury *et al* concerned with the resolution and scale at which they were drawing (automatic) pen and ink illustrations? (*one or two sentences*)

(c) In 1996 Meier described a system for painterly animations (e.g. the haystacks animation). In 1999 Kowalsky *et al* described a system for interactive rendering of cartoonish scenes (e.g. the Dr. Seuss-like renderings). Aside from rendering performance, what was a major challenge that the latter system had to address in moving from an offline animation system to an interactive system? (*one or two sentences*)

(d) What is a “graftal”? (one sentence)

(e) Is the following statement True or False:  
*NPR is really cool!*

## Q6: IBR

- (a) What are two advantages of using IBR rather than a ray tracer rendering pictures from a conventional computer graphics model? (*one sentence each*)
- (b) What are the seven dimensions over which the plenoptic function is parameterized?  
(*write words rather than just symbols*)
- (c) The “lightfield” or “lumigraph” is a lower-dimensional approximation to the plenoptic function. What dimensions were left out?
- (d) When rendering from a lightfield/lumigraph, why is it useful to have an approximate geometric representation of the object being rendered? (*a picture might help*)

## Q7: Potpourri

(a) State one advantage and one disadvantage of using a random threshold rather than a fixed threshold when halftoning an image. (*one sentence each*)

(b) State the two main conceptual uses of the alpha channel in a four-channel image. (*two phrases*)

(c) Give an example of temporal aliasing in an animation sequence.

(e) Using shading that is interpolated over faces in a mesh, what is the problem with T-vertices?

(d) Why would Winkenbach's pen-and-ink rendering scheme (that made the brick cabin picture) behave badly for animated sequences?

(f) Is the intersection of two BSP trees representing space occupancy log, linear, or quadratic in terms of the number of leaf cells? Why?