CSCI 4530/6530 Advanced Computer Graphics — Quiz 1
Friday March 10, 2017 — 2pm-3:50pm

Name:

RCS username:

This quiz is closed book & closed notes except for one 8.5x11 (double-sided) sheet of notes.

Please state clearly any assumptions that you made in interpreting a question.

Write your answer in the box provided below each question. Be sure to write neatly. If we can't read your solution, we won't be able to give you full credit for your work.

1	/ 5
2	/ 22
3	/ 8
4	/ 7
6	/ 8
Total	/ 50

1 Subdivision Implementation Details [/5]

What is the role of the "vertex parent" data structure in the subdivision surface implementation from Homework 1? If the information provided by this data structure (or an alternate storage of this data) is not used on each subdivision iteration, what artifacts will appear in the mesh? How would performance be affected if this data were not stored, but instead was recalculated/searched for each time it was needed? Please be specific. Write 3-4 concise and complete sentences.

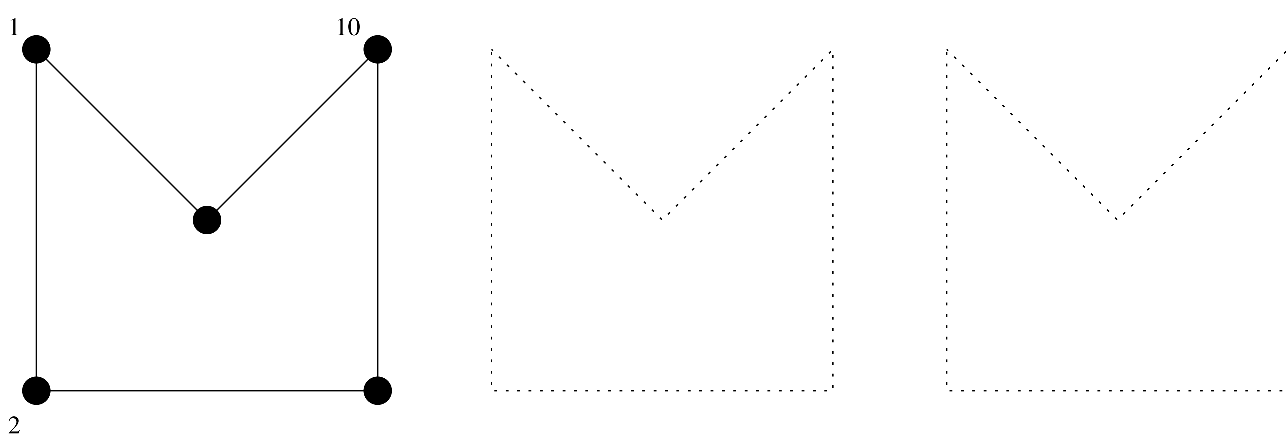
2 Sketching Graphics [/22]

2.1 Definition: Genus & Homeomorphic [/4]

Define the terms "genus" and "homeomorphic" with an neat and informative diagram *and* 2-3 concise and complete sentences.

2.2 Subdivision with Creases [/6]

Examine the 2D "mesh" below. Think of it as the cross-section of an extruded tube mesh going into the paper. Three of the vertices are tagged as creases with integer values. The crease values are applied to the mesh edges perpendicular to the paper. The other two vertices/edges are not creased. Your task is to perform two rounds of subdivision on this mesh. In each new diagram, draw vertices from the previous iteration as filled in disks and the new vertices as open circles. Draw the approximate position after smoothing. Label all vertices that have non-zero crease values.

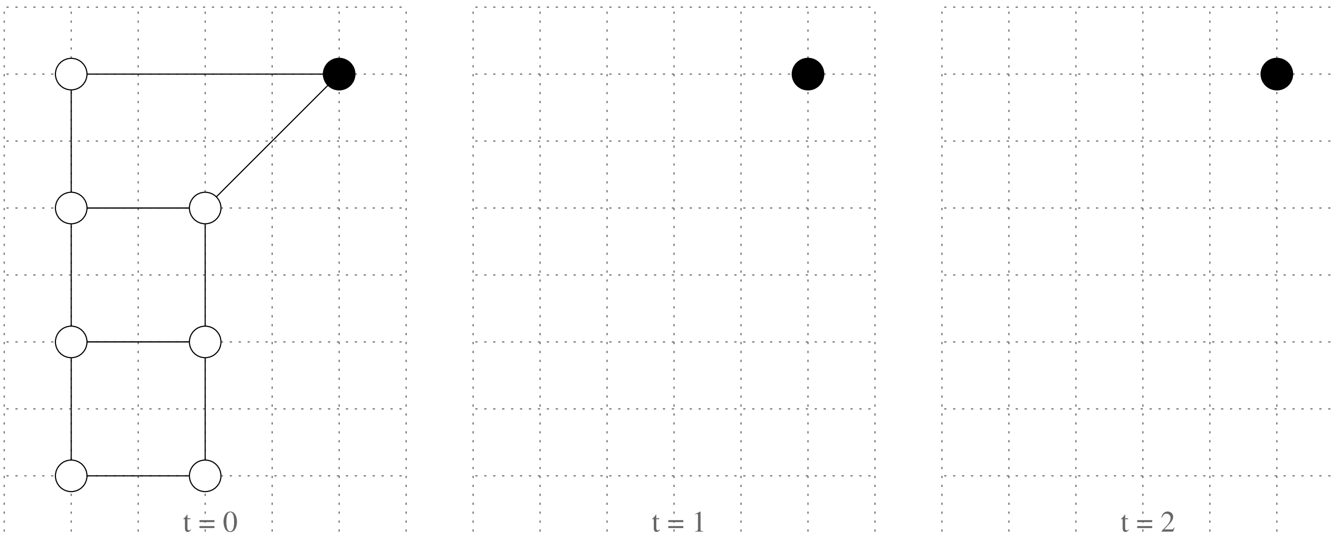


2.3 Mass-Spring Simulation [/6]

Now let's sketch the first few frames of a 2D explicit Euler mass-spring simulation for a 2x4 cloth network of uniform masses using *structural* and *shear* springs but no *flexion* springs. The structural springs are twice as stiff as the shear springs. One vertex of the cloth (the black node) has been instantaneously grabbed and anchored to the grid. The rest length of the structural springs is *2 grid spaces*, that is, the two structural springs attached to the anchor are initially stretched. There is *no gravity* in this simulation. The initial velocity of all masses is zero.

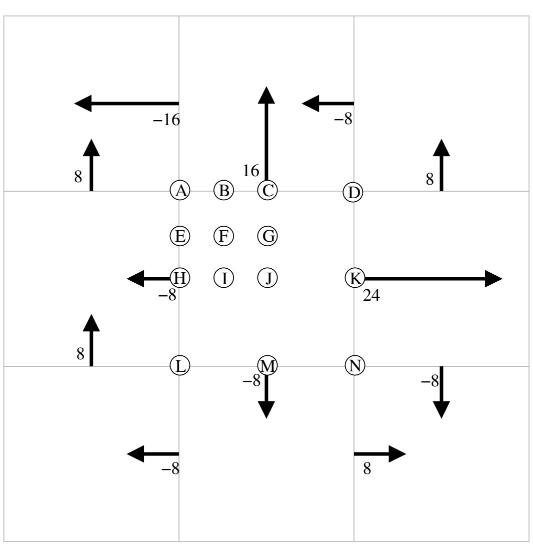
In each frame of the simulation, for each node, draw one or more arrows representing *the different individual spring forces affecting that node.* The length of each force arrow should indicate the relative magnitude of the force and the arrowhead should indicate the direction of the force. If a spring is currently at rest length, don't draw an arrow for that spring force. If all individual spring forces on a mass are zero, draw an X on that mass.

Assuming a reasonable spring stiffness and a reasonable timestep, draw the position of each mass and structural spring in each subsequent frame. Don't forget about the shear spring forces! Do not use the Provot spring correction method in this simulation. Please be neat :)



2.4 Fluid Velocity Interpolation [/6]

Consider the 3x3x1 grid of cells with the current u (horizontal) and v (vertical) face velocities as labeled below. Using the interpolation scheme described in Foster & Metaxas, determine the interpolated 2D velocity (x = horizontal, y = vertical) at the lettered white query dots in the diagram below. Write the 2D velocities in the corresponding boxes on the right. Be sure to use the correct sign: for x, left is negative & right is positive; for y, down is negative & up is positive.



A	B	C	D
(,)	(,)	(,)	(,)
E	**F**	**G**	
(,)	(,)	(,)	
H	**I**	**J**	**K**
(,)	(,)	(,)	(,)
L		**M**	**N**
(,)		(,)	(,)

3 Truthiness [/8]

Pick 9 (and only 9!) of the statements below to identify, and identify each of those 9 statements as "true" or "false". Leave the other two statements blank.

	To maintain stability in an explicit Euler mass-spring simulation, if the number of simulation iterations per second of animation is halved (e.g., the timestep is doubled), the spring stiffness should be doubled.
	In the paper "Real-Time Hand-Tracking with a Color Glove" by Wang & Popovic, a single camera tracked the orientation and pose of a hand, but was not able to robustly determine the depth of the hand from the camera.
	Watertight models of arbitrary topology can be easily constructed and edited with trimmed bicubic Bezier patches.
	The half-edge data structure may use twice as much memory to store adjacency, but the key advantage (yielding simpler code) is a consistent orientation of edges with respect to neighboring edges, faces, and vertices.
	Spatial data structures like an octree or oriented bounding boxes or a k-d tree can be used to improve the performance of physical simulations involving collision detection.
	The Loop subdivision limit surface of a cube mesh is dependent on the initial triangulation.
	Affine transformations preserve angles and distances.
	The paper "Untangling Cloth" by Baraff, Witkin, and Kass argues that it is not feasible to build robust cloth simulations with collision detection and that animators must ensure that clothed objects never self-intersect.
	Because homogeneous coordinates are not capable of compactly representing translations, they are not useful for general-purpose animation.
	Without at least a little damping in a spring-mass simulation (or viscosity in a fluid simulation) a discrete time-step simulation may never fully come to rest.
	The "Graphical Modeling and Animation of Brittle Fracture" by O'Brien & Hodgins presents an accurate simulation method for anisotropic materials.

4 Potpourri [/7]

4.1 Curves and Surfaces Reading [/4]

Which paper did you read: "Teddy: A Sketching Interface for 3D Freeform Design" or "Geometry Images"? Describe a key contribution from this paper and a specific technological challenge and how it was solved (with appropriate level of detail). Write 3-4 concise and well written sentences.

4.2 Videos [/3]

Choose one of the short animations we have watched at the beginning of lecture and describe one or more relevant technical advances in computer graphics that were necessary to create a successful animation. Specific details are not necessary, just convince me that you were paying attention in class :) Write 2 or 3 sentences.

5 Transformations & Matrix Representation [/8]

Write down the 3x3 matrix that transforms this set of 4 points:

A: (0, 0) B: (1, 0) C: (1, 1) D: (0, 1)

to these new positions:

A': (1, -1) B': (1, 1) C': (-1, 1) D': (-1, -1)

Show your work.