CSCI 4539/6530 Advanced Computer Graphics — Quiz 1
Friday March 5, 2010 — 2pm-3:50pm

Name:

RCS username:

1	/ 5
2	/ 12
3	/ 9
4	/ 9
5	/ 7
6	/ 8
Total	/ 50

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.

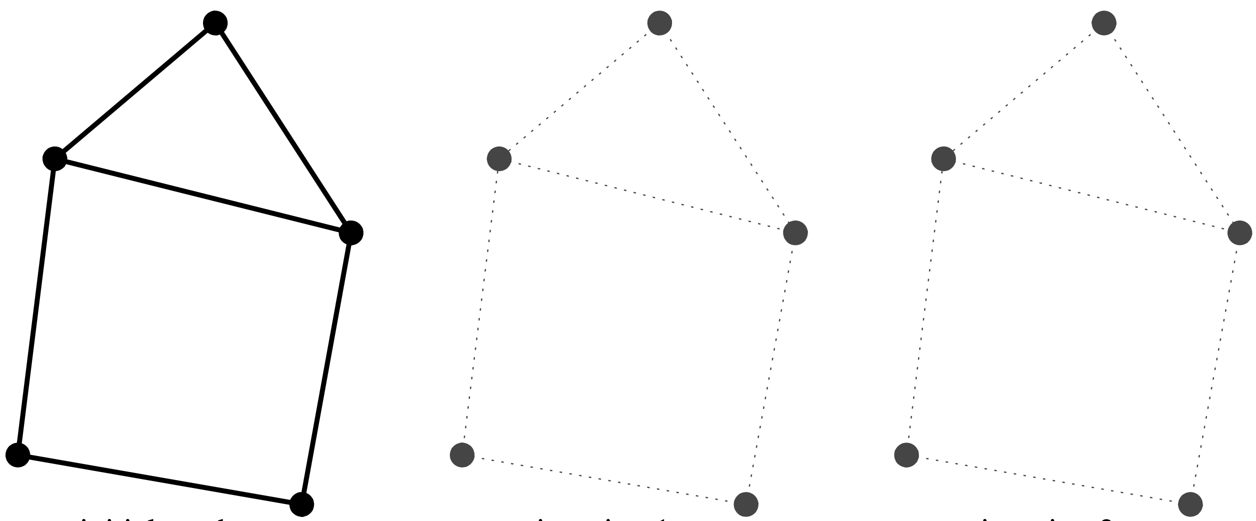
1 Collision Detection [/5]

We read 2 papers about collision detection, "Untangling Cloth" by Baraff, Witkin, & Kass and "I-COLLIDE: An Interactive and Exact Collision Detection System for Large-scaled Environments" by Cohen, Lin, Manocha, and Ponamgi. Which paper did you read? For that paper, what was the target application, what was the problem with existing technology for collision detection, and what specific challenge did they need to solve? Write 3-4 concise and well written sentences.

2 Sketching Graphics [/12]

2.1 Subdivision Network[/5]

Draw the network topology for the first two iterations of Catmull-Clark subdivision on the mesh below. Focus on the number of vertices, edges, and polygons and their relative position and connectivity. Don't worry about the application of the stencil or rules for how to calculate the final vertex positions.

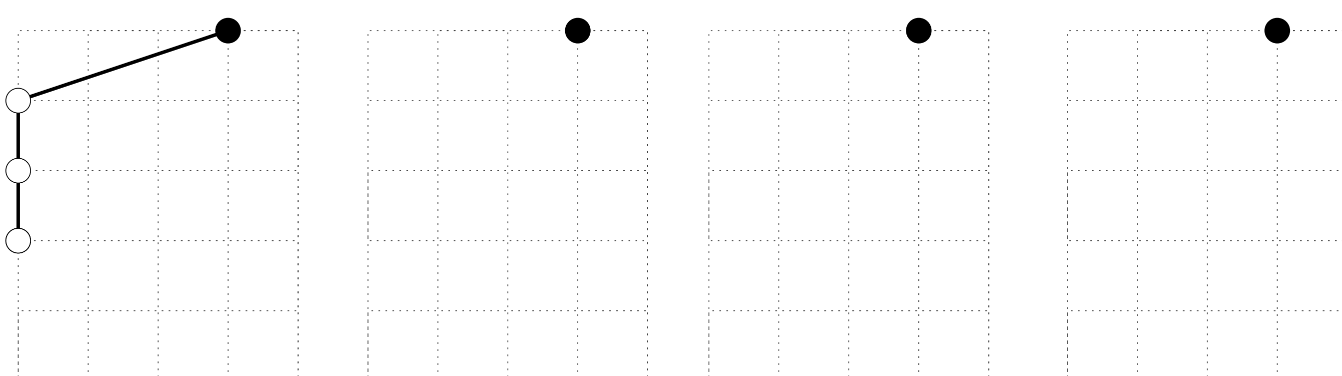


initial mesh iteration 1 iteration 2

2.2 Mass-Spring Simulation [/7]

In this problem you will sketch the first few frames of a 2D explicit Euler mass-spring simulation for a network of three springs of uniform stiffness connecting four uniform masses. The black-colored mass is anchored to the ceiling. The rest length of all springs is a single grid space, that is, the spring attached to the anchor is initially stretched, the other two are at rest length. Gravity points downward. The initial velocity of all masses is zero.

In each frame of the simulation below draw an arrow for each force acting on each particle, that is, draw separately the force of gravity and each spring force. The length of each arrow should indicate the relative magnitude of the force. Assuming a reasonable spring stiffness and a reasonable timestep, drawn the position of each mass and spring in each subsequent frame. Do not use the Provot spring correction method in this simulation. Please be neat :)



t = 0 t = 1 t = 2 t= 3

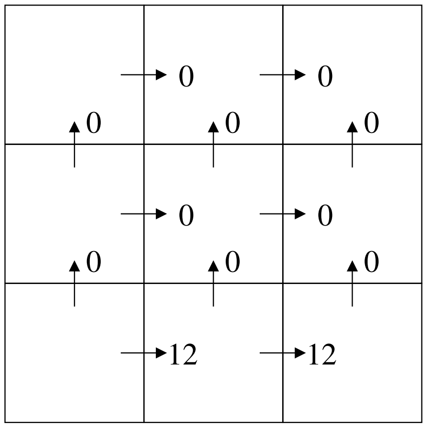
3 Truthiness [/9]

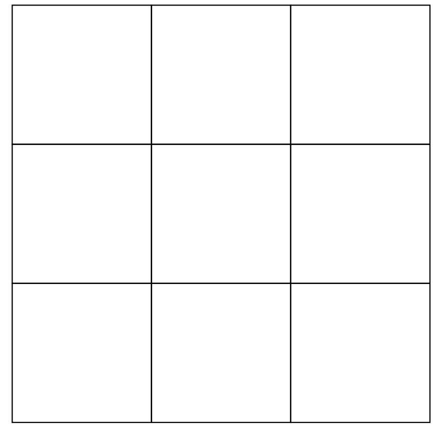
Identify each statement below as "true" or "false".

	Affine transformations preserve angles and distances.
	Gouraud shading is used to reduce the appearance of polygonal silhouette edges.
	The Loop subdivision limit surface of a cube mesh is dependent on the initial triangulation.
	Watertight models of arbitrary topology can be easily constructed and edited with trimmed bicubic Bezier patches.
	To maintain stability in an explicit Euler Mass-Spring simulation, if the spring stiffness is doubled, the number of simulation iterations per second of animation must be halved.
	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.
	"Geometry Images" by Gu, Gortler, & Hoppe demonstrates how image compression techniques can be applied to 3D mesh compression.
	"Teddy: A Sketching Interface for 3D Freeform Design" by Igarashi et al. presents a new modeling system for expert users that will ultimately replace high-end tools like Maya.
	The "Graphical Modeling and Animation of Brittle Fracture" by O'Brien & Hodgins presents an approximation of physics and material science to achieve real-time simulation frame rates appropriate for use in video games.

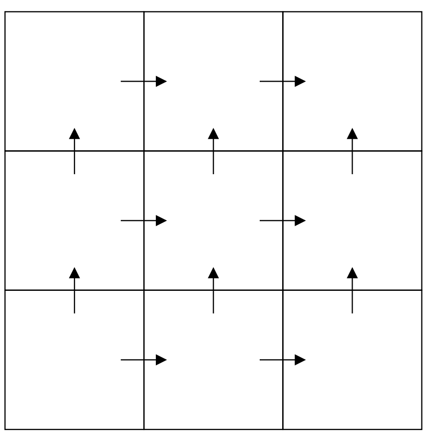
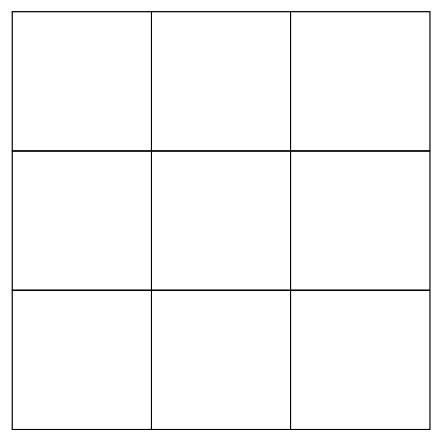
4 Incompressible Fluid Simulation [/9]

Consider the 3x3x1 grid of cells with the initial u and v face velocities as labeled below. No flow should cross the outer boundaries of the grid. Label the cells in the plot on the right with their corresponding *divergence* (net inflow/outflow).

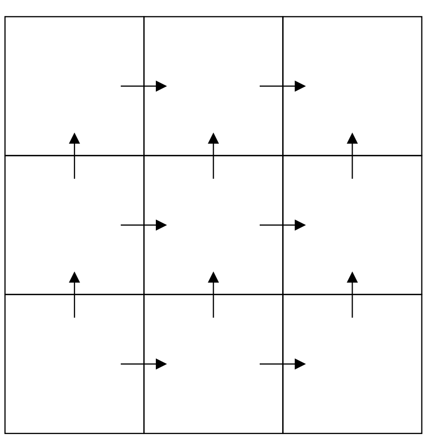




To model an incompressible fluid such as water, the divergence of each cell should be zero. In the cells below, fill in the velocities (left) and corresponding divergence (right) resulting after the *first iteration (or sweep)* of Foster & Metaxas' divergence correction from "Realistic Animation of Liquids". Note the direction of the velocities (use negative values if the flow travels in the reverse direction). Traverse the cells from left to right, top row first.

Label the figure below with a set of *plausible* velocities when this divergence correction has converged after many iterations. The values don't have to exactly match a computer simulation, just fill in values that demonstrate you know what a converged solution for this example should look like.



5 Potpourri [/7]

5.1 Progressive Mesh Efficiency [/4]

Without a priority queue (or similar data structure), what is the order notation to build a complete Progressive Mesh from an input model with n triangles? Using a priority queue, what is the order notation? Justify your answer (write 2 or 3 sentences).

5.2 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 successfully create the animation. Specific details are not necessary, just convince me that you were paying attention in class :) Write 2 or 3 sentences.

6 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, 0) C': (0, 0) D': (0, -1)

Show your work.