# CSCI 4530/6530 Advanced Computer Graphics — Quiz 1
# Friday February 28, 2014 — 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 | / 21 |
| 3 | / 9 |
| 4 | / 7 |
| 6 | / 8 |
| Total | / 50 |

## 1 Subdivision Implementation Details [ /5]

Describe the difference between the original Loop subdivision and the extension to include crease edges. How are the resulting meshes different? What are the implementation details and how are the implementation details different? Write 3-4 concise and complete sentences. Use your *words* thoughtfully (don't rely on a diagram to answer the question).

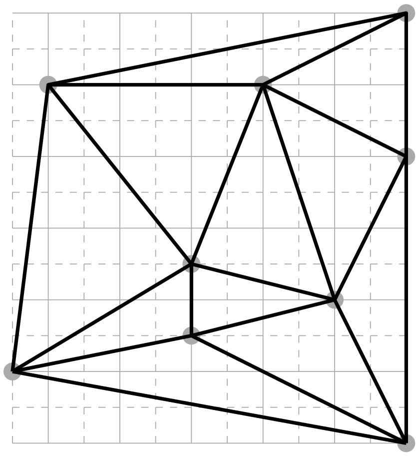
# 2 Sketching Graphics [ /21]

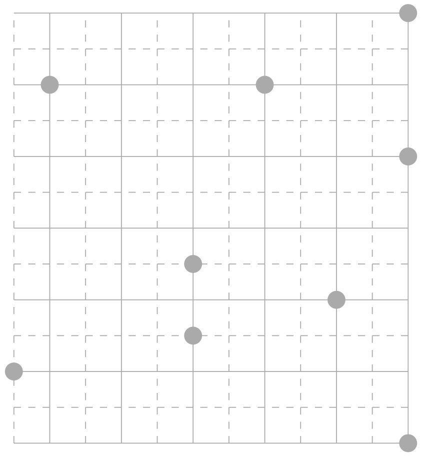
## 2.1 Simplification [ /7]

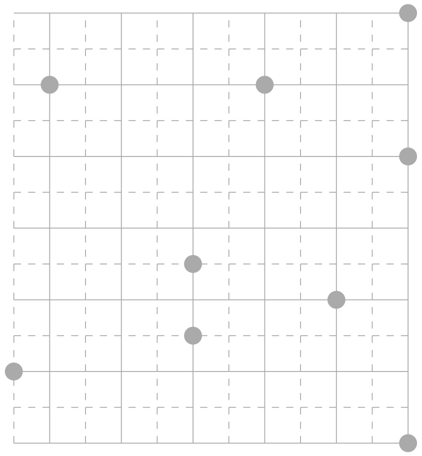
Given the 2D mesh below, sketch the results of performing a sequence of 3 edge collapses, one-at-a-time, as described in the "Progressive Meshes" paper by Hoppe. Always choose the shortest edge in the mesh, *unless that edge collapse is invalid*. If there are two or more edges with identical length, choose one at random. In 2D, an invalid edge collapse is one that creates an element with zero area. The position of the "new" vertex in each collapse should be the midpoint of the collapsed edge.

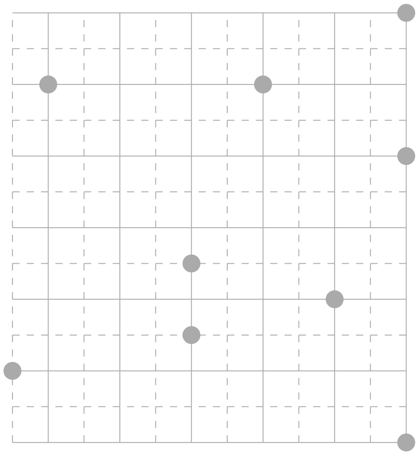
In the initial mesh diagram mark the first edge to be collapsed with an 'X', and in the 2nd diagram ("after collapse #1") draw the mesh that results after performing the indicated collapse. Then in the 2nd diagram mark the 2nd edge to be collapsed with an 'X', and draw the resulting mesh in the 3rd diagram ("after collapse #2"). And similarly, for the diagram "after collapse #3".

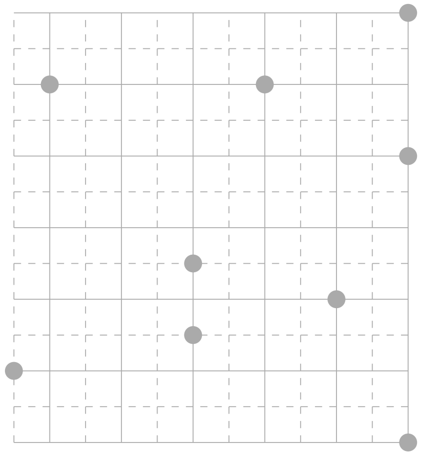
Please be neat! The vertices of the initial mesh are marked in grey in each successive grid to help guide your sketching. Two extra grids are provided if you need to redraw one of the diagrams. If you use an extra grid, please label which diagram it is replacing.

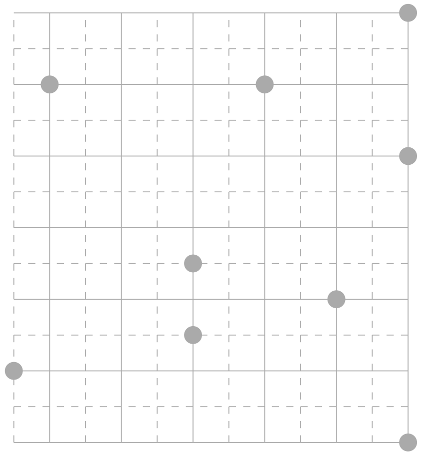

initial mesh


after collapse #1


after collapse #2


after collapse #3

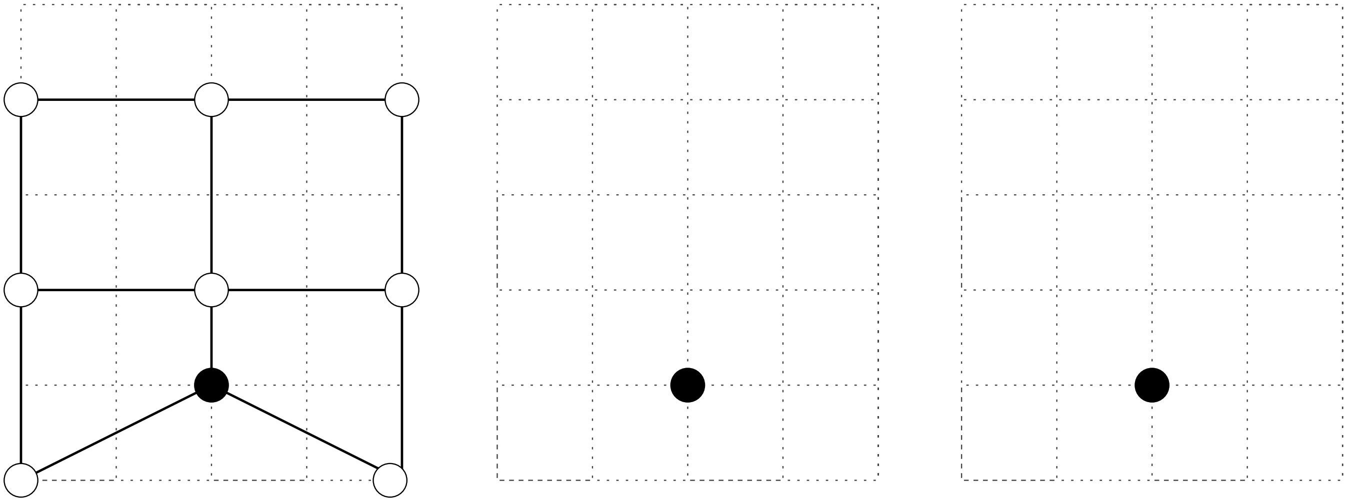

(extra grid)


(extra grid)

## 2.2 Mass-Spring Simulation [ /7]

In the next problem you will sketch the first few frames of a 2D *explicit Euler* mass-spring simulation for a 3x3 cloth network of uniform masses using *only* structural springs with uniform stiffness. One vertex of the cloth (the black node) has been pushed inwards and anchored to the grid. The rest length of all springs is *2 grid spaces*, that is, the three springs attached to the anchor are initially stretched or squished, all others are at rest length. There is *no gravity* in this simulation. The initial velocity of all masses is zero.

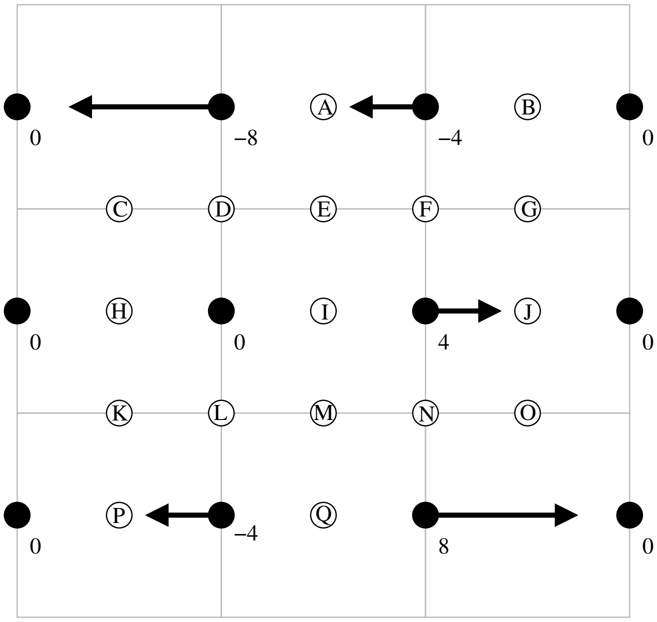
In each frame of the simulation below draw an arrow for the *net force* acting on each node. If there is no force acting on a mass in one frame, draw an X on that mass. The length of each force arrow should indicate the relative magnitude of the force. Assuming a reasonable spring stiffness and a reasonable 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 :)

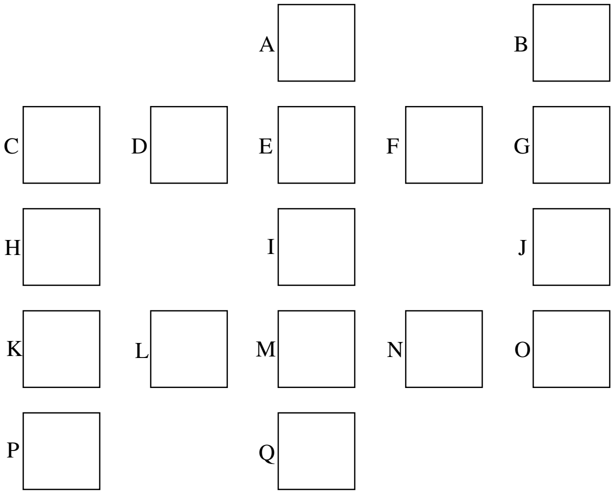


t = 0    t = 1    t = 2

## 2.3 Fluid Velocity Interpolation [ /7]

Consider the 3x3x1 grid of cells with the current $u$ (horizontal) face velocities as labeled below, at the solid black dots. Using the interpolation scheme described in Foster & Metaxas, determine the horizontal velocity at the lettered white dots in the diagram below. Write the velocities in corresponding boxes on the right. Be sure to use the correct sign: left is negative & right is positive.





## 3 Truthiness [ /9]

Identify each statement below as “true” or “false”.

A cubic Bezier curve is an approximation curve, and a cubic B-Spline curve is an interpolation curve.

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 also be halved.

The “Graphical Modeling and Animation of Brittle Fracture” by O’Brien & Hodgins presents an accurate simulation method for isotropic materials.

Rigid body transformations preserve angles but do not preserve distances.

Implicit surfaces can be converted into explicit surface representations using the Marching Cubes algorithm by Lorensen & Cline.

The Doo Sabin subdivision limit surface of a cube mesh is a perfect sphere.

“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.

Because homogeneous coordinates are not capable of compactly representing translations, they are not useful for general-purpose animation.

A teacup with a handle is homeomorphic to a torus-shaped donut.

# 4 Potpourri [ 7]

## 4.1 Readings on Volumetric Data Structures [ /4]

For our lecture on volumetric data structures, you were required to read a paper on Object-Oriented Bounding Boxes or one of two papers on Octree Textures. Which paper did you read? Describe the target application and two specific technological advances presented in that paper. 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': (0, 1) C': (1, 1) D': (0, 1)

Show your work.