Spring ’20 CIS 410/510 Final Review

The exam will be a 120-minute quiz on Canvas, and can be started between 10:15 and 10:45 AM.

You may use any course resources during the exam (slides, assignments, textbooks, piazza), but not the internet in general. You may not collaborate with your classmates in any way.

Questions will be in short-answer format with partial credit for partial answers.

You will be asked to write pseudocode resembling Unity C#.

You may assume that all problems use row vectors (just like the textbook).

You may assume that you’re working with a vector-math library that supports vector addition, vector subtraction, vector-scalar multiplication (e.g., `Vector3 u = 2.0f * v + w`), a dot-product function `float dot(Vector3 a, Vector3 b)`, a cross-product function `Vector3 cross(Vector3 a, Vector3 b)`, and basic scalar functions (e.g., `sqrt`, `pow`, `sin`, `cos`, `arccos`, `cot`).

Topics:

- Vector-vector addition and subtraction, vector-scalar multiplication, dot, cross products
- 1x4 vectors, 4x4 matrices, vector-matrix multiplication, matrix-matrix multiplication
- Rotation, translation, and scaling transformations, Euler angles, Gimbal lock, quaternions
- Coordinate spaces – model, world, camera, projection
- Types of lights – ambient, directional, point, spot – properties and uses
- Ambient, diffuse, and specular lighting equations
- 3D sound - listeners, emitters, Doppler effect, occlusion/obstruction
- Digital Signal Processing (DSP) - uses for reverb, pitch shifting, low-pass filtering
- Rays casting, uses in games
- Sphere-sphere, AABB-AABB collision implementations, AABB from points
- Semi-Implicit Euler Integration equations (from forces to linear velocities to positions)
- Path nodes and navigation meshes, Euclidian, Manhattan distances
- Greedy best-first and A* pathfinding algorithms

1. [10] Describe three features in games that could be implemented using ray casting:

2. [10] Briefly describe a situation where it would be appropriate to use each of the following Digital Signal Processing (DSP) effects in a game: reverb, pitch shifting (other than Doppler), low-pass filtering:

3. [15] Consider the following function:
   ```c#
   void aabb(Vector3[] points, out Vector3 min, out Vector3 max);
   ```
   Implement the above function so that it configures the min and max vertices defining an Axis Aligned Bounding Box (AABB) exactly encompassing the specified points:

4. [10] Is Manhattan distance more computationally efficient to compute than Euclidian distance? Why or why not?