CMSC 425: Lecture 23
Semester Review
Tuesday, May 7, 2013

Overview: As mentioned in our first lecture of this semester, we could have easily devoted many courses (and perhaps even an entire degree) to teach you the diversity of skills that are relevant to the design and development of computer games. The design of modern computer games involves an extraordinary array of technologies and skills (both technical and artistic). Given that we had only one course in which to work with, it has been necessary to severely limit the topics that could be covered.

This semester I decided to focus the course in a different direction than what I have done in the past. In particular (for better or worse), I chose to avoid a relatively glossy treatment of a wide variety of software technologies, and instead focus on giving you an understanding of a relatively small number of mathematically deeper topics. (The one practical element of software technology that we did spend time on has been OpenGL and programming interactive computer graphics.)

I view this semester as being broken up into the following high-level topics:

- Basics of interactive computer graphics
- Useful data structures for game programming
- Basics of animation
- Artificial intelligence for games
- Multiplayer games and networking

Introduction to Interactive Computer Graphics:

- *Computer Game and Graphics System Architectures*: The basic structure of graphics processing units (GPUs) and the graphics pipeline.
- *Basic Elements of OpenGL and GLUT*: Event-driven programming and callback-based processing of user inputs.
- *Drawing in OpenGL*: Basic OpenGL drawing and the use of the matrix stack. Specifying the camera position and perspective projection.
- *Lighting and Texturing*: OpenGL's lighting model and texture mapping capabilities.

Data Structures for Games:

- *Meshes and Manifolds*: Triangle and other types of meshes. 2-manifolds and the DCEL data structure.
- *Geometric Graphs*: Various geometric graph structures, including visibility graphs, Yao graphs and θ-graphs, Voronoi diagrams and Delaunay triangulations, relative neighborhood graphs and Gabriel graphs.
- *Geometric Index Structures*: Bounding enclosures, grids, quadtrees and their variants.

Animation for Games:

- *Skeletal Animation*: Bind (reference) pose, local-pose transformation and its inverse, forward and inverse kinematics.
- *Animation and Skinning*: Joints, weights, and blended skinning.

Artificial Intelligence for Games:

- *AI Basics*: Agents and their varieties.
- *Planning Motion*: Configuration spaces, potential-field methods, waypoints and roadmaps, medial-axis.
- *Finding Paths*: Best-first search, Dijkstra's algorithm, and A* search. Admissible and consistent heuristics.
- *Multiple Agent Motion*: Particle systems, flocking, velocity obstacles, and reciprocal-based collision avoidance.

Decision Making: Rule-based systems, finite-state machines, and behavior trees.

Multiplayer Games and Networking:

- *Networking for Games*: Basic network structure, latency issues, common protocols, area-of-interest management.
- *Cheating in Multiplayer Games*: Common cheating techniques, such as information exposure, reflex augmentation, authoritative clients, compromised Servers, bugs and design loopholes, infrastructure weaknesses.

What We Didn't Cover: As mentioned above, the number of topics that we did not have time to cover could fill many courses. There are a few topics that I wish that we had more time to discuss including:

- Physics
- Game-engine structure
- Complex geometric models and level-of-detail control
- Sound and audio
- ...