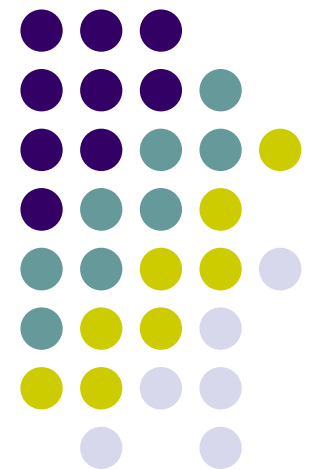


Computer Graphics

CS 543 – Midterm Review

Prof Emmanuel Agu

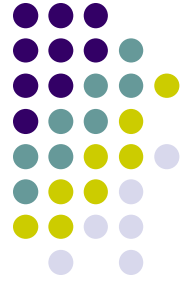
*Computer Science Dept.
Worcester Polytechnic Institute (WPI)*





Exam Overview

- Tuesday, October 29, 2013 in-class
- Will cover up to lecture 6 (lighting, shading and materials)
 - Includes today's parts on cook-torrance, BRDFs
- Can bring:
 - One page cheat-sheet, hand-written (not typed)
 - Calculator
- Will test:
 - Theoretical concepts
 - Mathematics
 - Algorithms
 - Programming
 - OpenGL/GLSL knowledge (program structure and some commands)



What am I Really Testing?

- Understanding of
 - concepts (NOT only programming)
 - programming (pseudocode/syntax)
- Test that:
 - you can plug in numbers by hand to check your programs
 - you did the projects
 - you understand what you did in projects



General Advise

- **Read your projects** and refresh memory of what you did
- **Read the slides:** worst case – if you understand slides, you're more than 50% prepared
- Focus on **Mathematical results, concepts, algorithms**
- Plug numbers: calculate by hand
- Try to **predict subtle changes** to algorithm.. What ifs?..
- **Past exams:** One sample midterm is on website
- All lectures have references. Look at refs to focus reading
- Do all readings I asked you to do on your own



Grading Policy

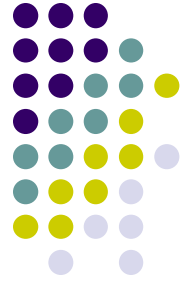
- I try to give as much partial credit as possible
- In time constraints, laying out outline of solution gets you healthy chunk of points
- Try to write something for each question
- Many questions will be easy, exponentially harder to score higher in exam

Introduction



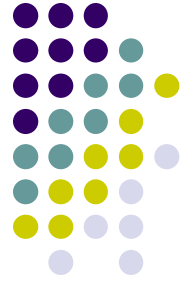
- Motivation for CG
- Uses of CG (simulation, image processing, movies, viz, etc)
- Elements of CG (polylines, raster images, filled regions, etc)
- Device dependent graphics libraries (OpenGL, DirectX, etc)

OpenGL/GLUT



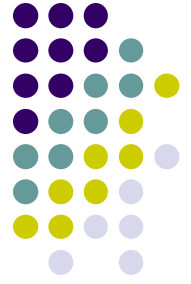
- High-level:
 - What is OpenGL?
 - What is GLUT?
 - What is GLSL
 - Functionality, how do they work together?
- Design features: low-level API, event-driven, portability, etc
- Sequential Vs. Event-driven programming
- OpenGL/GLUT program structure (create window, init, callback registration, etc)
- GLUT callback functions (registration and response to events)

OpenGL Drawing



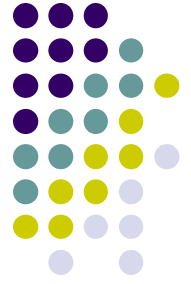
- Vertex Buffer Objects
- `glDrawArrays`
- OpenGL :
 - Drawing primitives: `GL_POINTS`, `GL_LINES`, etc (should be conversant with the behaviors of major primitives)
 - Data types
 - Interaction: keyboard, mouse (`GLUT_LEFT_BUTTON`, etc)
 - OpenGL state
- GLSL Command format/syntax
- Vertex and fragments shaders
- How GLSL works

2D Graphics: Coordinate Systems

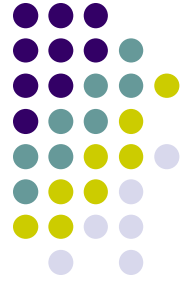


- Screen coordinate system/Viewport
- World coordinate system/World window
- Setting Viewport
- Tiling, aspect ratio

Fractals



- What are fractals?
 - Self similarity
 - Applications (clouds, grass, terrain etc)
- Mandelbrot set
 - Complex numbers: s , c , orbits, complex number math
 - Dwell function
 - Assigning colors
 - Mapping mandelbrot to screen
- Koch curves, gingerbread man, hilbert transforms



Points, Scalars Vectors

- Vector Operations:
 - Addition, subtraction, scaling
 - Magnitude
 - Normalization
 - Dot product
 - Cross product
 - Finding angle between two vectors
- Standard unit vector
- Normal of a plane



Transforms

- Homogeneous coordinates Vs. Ordinary coordinates
- 2D/3D affine transforms: rotation, scaling, translation, shearing
- Should be able to take problem description and build transforms and apply to vertices
- 2D: rotation (scaling, etc) about arbitrary center:
 - $T(P_x, P_y) R(\theta) T(-P_x, -P_y) * P$
- Composing transforms
- OpenGL transform commands (Rotate, Translate, Scale)
- 3D rotation:
 - x-roll, y-roll, z-roll, about arbitrary vector (Euler theorem) if given azimuth, latitude of vector or (x, y, z) of normalized vector
- Matrix multiplication!!



Modeling and 3D Viewing

- Drawing with Polygonal meshes
- Finding vertex normals
- Lookat(Eye, COI, Up) to set camera
 - How to build 3 new vectors for axes
 - How to build world-to-eye transformation
 - Pitch: nose up-down
 - Roll: roll body of plane
 - Yaw: move nose side to side



Projection

- Projection:
 - View volume, near plane, far plane
 - Perspective(fovy, aspect, near, far) or
 - Frustum(left, right, bottom, top, near, far)
 - Ortho(left, right, bottom, top, near, far)
 - How to build Perspective and Ortho matrices
- Hierarchical 3D modeling
- Lighting, shading and materials
- Does NOT include shadows, fog, textures, etc