Midterm Grade Distribution

- 100: 1
- 90-100: 6
- 80-90: 14
- 70-80: 7
- 60-70: 4
- < 60: 5
Assignment 2 Grade Distribution

<table>
<thead>
<tr>
<th>Grade Range</th>
<th>Count</th>
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<tbody>
<tr>
<td>90-100</td>
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<tr>
<td>80-90</td>
<td>4</td>
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<td>70-80</td>
<td>2</td>
</tr>
<tr>
<td>60-70</td>
<td>4</td>
</tr>
<tr>
<td>&lt; 60</td>
<td>10</td>
</tr>
</tbody>
</table>
Apply for the StudCo Technology Committee

• Looking for students with a passion for technology
• All majors and experience levels welcome
• Projects will include:
  – Managing www.uvastudentcouncil.com
  – Maintaining SpeakUpUVA
  – Livestreaming StudCo meetings on the web
  – Finding creative new ways to use technology
• Applications at www.uvastudentcouncil.com
• Contact Kate McDowell (kam6zx) for details
PocketSonics

• Local startup company founded by BME professor Bill Walker.
• Looking for talented hard-working employees who can contribute to efforts in signal processing and imaging.
• Experience in C programming required, especially at the low level and in embedded environments.
• Chance to grow with a new company!!
• Contact: bwalker@PocketSonics.com
3D Object Representation

Jason Lawrence

CS 4810: Graphics

Acknowledgment: slides by Misha Kazhdan, Allison Klein, Tom Funkhouser, Adam Finkelstein and David Dobkin
3D Object Representation

• How do we ...
  ○ Represent 3D objects in a computer?
  ○ Construct such representations quickly and/or automatically with a computer?
  ○ Manipulate 3D objects with a computer?

Different methods for different object representations
3D Objects

How can this object be represented in a computer?
3D Objects

This one?

H&B Figure 10.46
How about this one?
3D Objects

This one?

H&B Figure 9.9
3D Objects

This one?
Representations of Geometry

• 3D Representations provide the foundations for
  o Computer Graphics
  o Computer-Aided Geometric Design
  o Visualization
  o Robotics

• They are languages for describing geometry
  data structures  algorithms

• Data structures determine algorithms!
3D Object Representations

• Raw data
  - Point cloud
  - Range image
  - Polygon soup

• Surfaces
  - Mesh
  - Subdivision
  - Parametric
  - Implicit

• Solids
  - Voxels
  - BSP tree
  - CSG
  - Sweep

• High-level structures
  - Scene graph
  - Skeleton
  - Application specific
Point Cloud

- Unstructured set of 3D point samples
  - Acquired from range finder, random sampling, particle system implementations, etc
Point Cloud

• Unstructured set of 3D point samples
  o Acquired from range finder, random sampling, particle system implementations, etc

Can associate colors/normals/etc. to the points

Hoppe
Range Image

- An image storing depth instead of color
  - Acquired from range scanners
Polygon Soup

- Unstructured set of polygons
  - Created with interactive modeling systems, combining range images, etc.
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Mesh

- Connected set of polygons (usually triangles)
  - May not be closed
Subdivision Surface

- Coarse mesh & subdivision rule
  - Define smooth surface as limit of sequence of refinements

Zorin & Schroeder
SIGGRAPH 99
Course Notes
Parametric Surface

- Tensor product spline patches
  - Careful use of constraints to maintain continuity

FvDFH Figure 11.44
Implicit Surface

- Points satisfying: $F(x,y,z) = 0$
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Voxels

- Uniform grid of volumetric samples
  - Acquired from CT, MRI, etc.

FvDFH Figure 12.20

Stanford Graphics Laboratory
BSP Tree

- Binary space partition with solid cells labeled
  - Constructed from polygonal representations
Constructive Solid Geometry (CSG)

- Hierarchy of boolean set operations (union, difference, intersect) applied to simple shapes

FvDFH Figure 12.27

H&B Figure 9.9
Sweep

- Solid swept by curve along trajectory

Stephen Chenney
U Wisconsin
Sweep

- Solid swept by curve along trajectory

- Curve may be arbitrary
- Sweep polygon may deform (scale, rotate) with respect to the path orientation

Stephen Chenney
U Wisconsin
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Scene Graph

• Union of objects at leaf nodes
Skeleton

- Graph of curves with radii
Application Specific

Apo A-1
(Theoretical Biophysics Group, University of Illinois at Urbana-Champaign)

Architectural Floorplan
Equivalence of Representations

- Thesis:
  - Each fundamental representation has enough expressive power to model the shape of any geometric object
  - It is possible to perform all geometric operations with any fundamental representation!

- Analogous to Turing-Equivalence:
  - All computers today are Turing-equivalent, but we still have many different processors
Computational Differences

- Efficiency
  - Combinatorial complexity
  - Space/time trade-offs
  - Numerical accuracy/stability

- Simplicity
  - Ease of acquisition
  - Hardware acceleration

- Usability
Surfaces

• What makes a good surface representation?
  o Concise
  o Local support
  o Affine invariant
  o Arbitrary topology
  o Guaranteed continuity
  o Natural parameterization
  o Efficient display
  o Efficient intersections
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Not Local Support
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