CS709a: Algorithms and Complexity

Focus: Spatial Data Structures and Algorithms

Instructor: Dan Coming
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Thursdays 4:00-6:45pm
Office hours after class
(or by appointment)

Questions/Discussion on Project 1

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Today

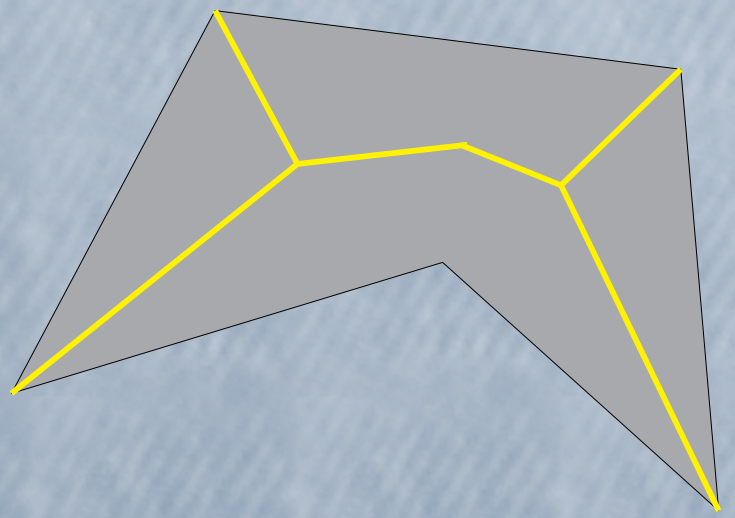
- Objects and queries
- Medial axis
- Bounding Volumes
- Paper presentation by Joe
  - "Fast GPU Ray Tracing of Dynamic Meshes using Geometry Images" by Nathan A. Carr, Jared Hoberock, Keenan Crane, and John C. Hart

Object Queries

- Objects are compound, may be collections of points, geometry, or regions in space
- Feature queries – given an object, find where it goes in space (e.g., which cells)
- Location queries – given a cell, identify objects in the cell and determine where the rest of the parts of the object(s) are contained
- Example from project 1 data

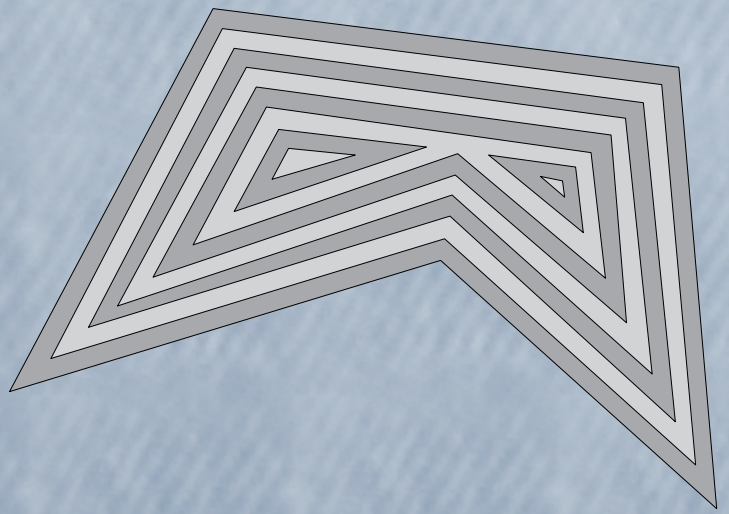
Medial Axis

- Find topological skeleton (yellow) of this object



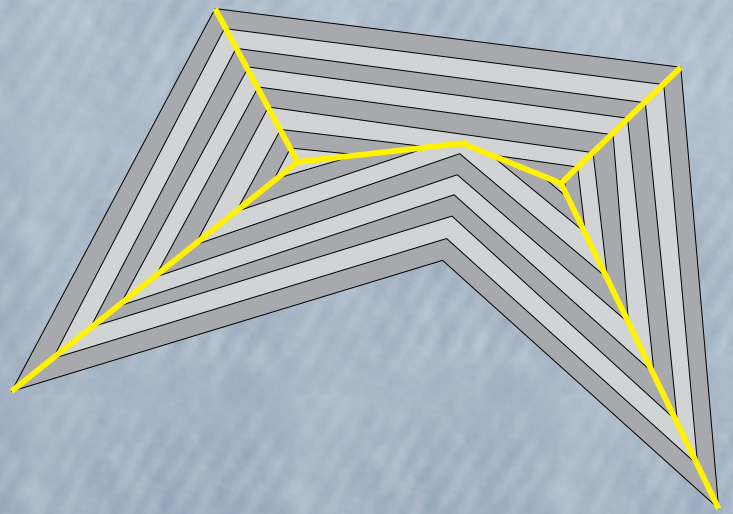
Medial Axis

- Find topological skeleton of this object
- Use distance from boundary to get equidistant topological lines (like a topo map)



Medial Axis

- Find topological skeleton of this object
- Use distance from boundary to get equidistant topological lines (like a topo map)
- Connect vertices of adjacent topological lines in gradient direction



Bounding Volumes (BV)

- Objects are likely to be non-convex
- Convex is easier

→ Convex decomposition

- Bounding Volumes
  - Convex shapes
  - Simple operations
  - Completely contain arbitrary geometry

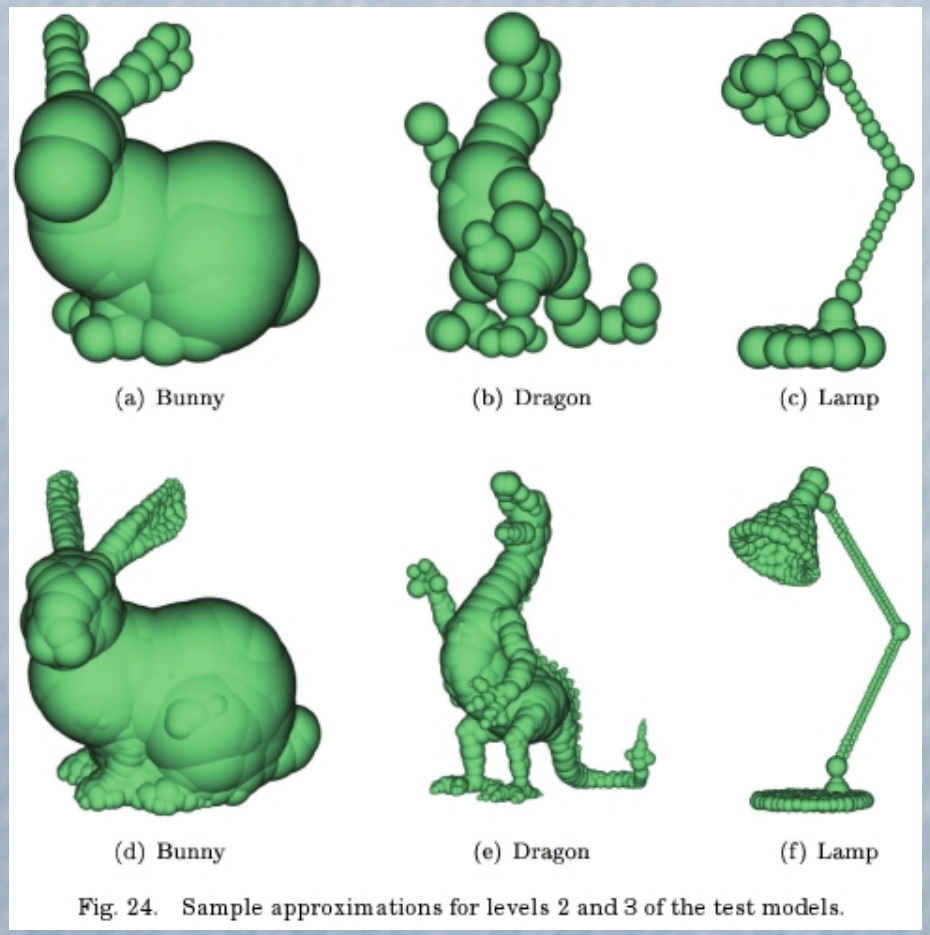
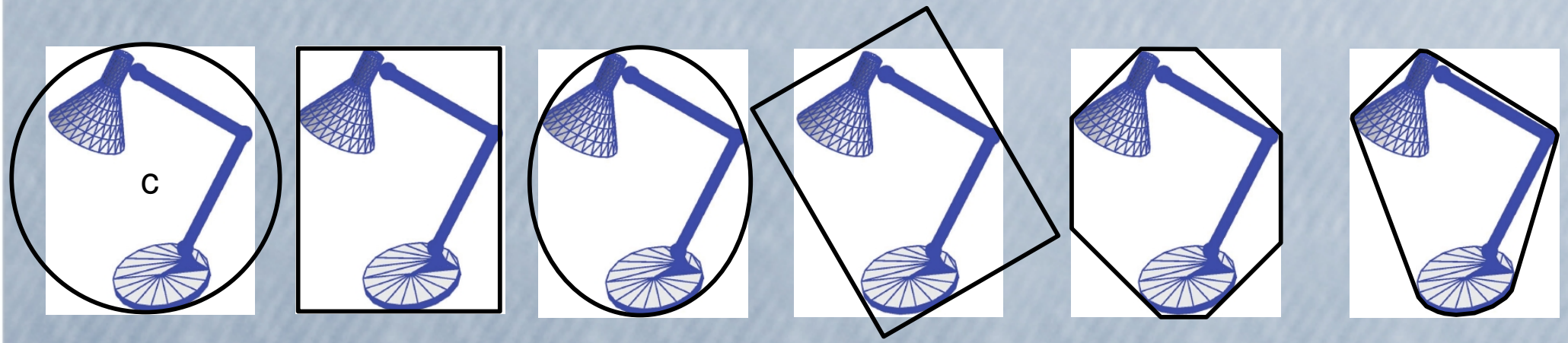


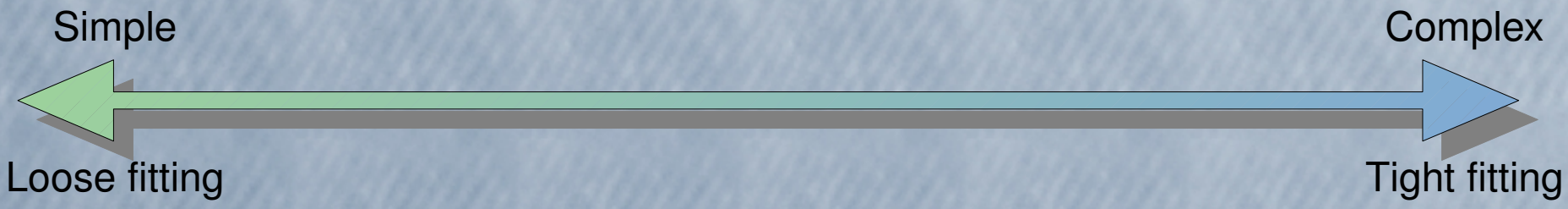
Fig. 24. Sample approximations for levels 2 and 3 of the test models.

Image: Bradshaw, G. and O'Sullivan, C. 2004. Adaptive medial-axis approximation for sphere-tree construction. ACM Trans. Graph. 23, 1 (Jan. 2004), 1-26.

Complexity – Fitness Tradeoff



Circle/Sphere | Axis-Aligned Bounding Box(AABB) | Ellips{e|oid} | Oriented Box | Discrete Oriented Polytope (DOP) | Convex Hull



Fitting Bounding Volumes

- Finding a valid bounding volume is easy
- Minimizing its area/volume can be hard
- Approximate bounding volumes
  - Leave wiggle room for moving / deforming objects
  - Save build time in BVH

Next Time

- Project 1 Presentations
- Reminder: Project 1 due Feb 25, 11:59pm
  - (email **one** tarball containing all code and documentation to dan.coming@dri.edu)