
Collision Detection

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Course URL:
<http://jupiter.kaist.ac.kr/~sungeui/SGA/>

KAIST

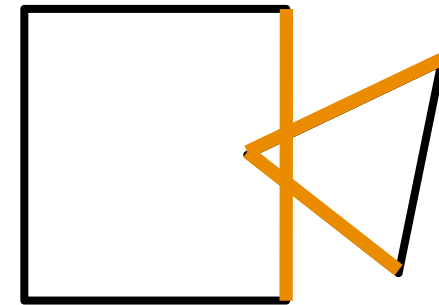


Course Administration

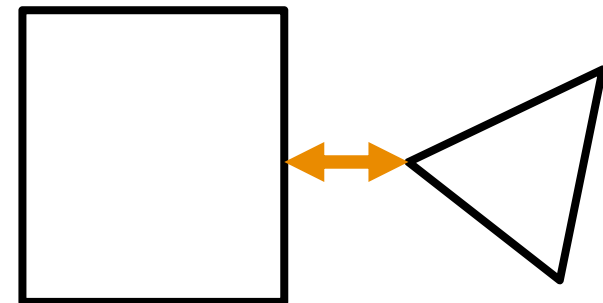
- **Make progresses on your chosen topic**
 - Write down toward the mid-term report, whose deadline is Nov-6
- **Presentation schedule**

Proximity Queries

- **Collision detection**
 - Checks whether there is collision between objects
 - Reports colliding primitives if any
- **Minimum separation distance**
 - Compute a minimum distance between two objects and report primitives realizing the distance

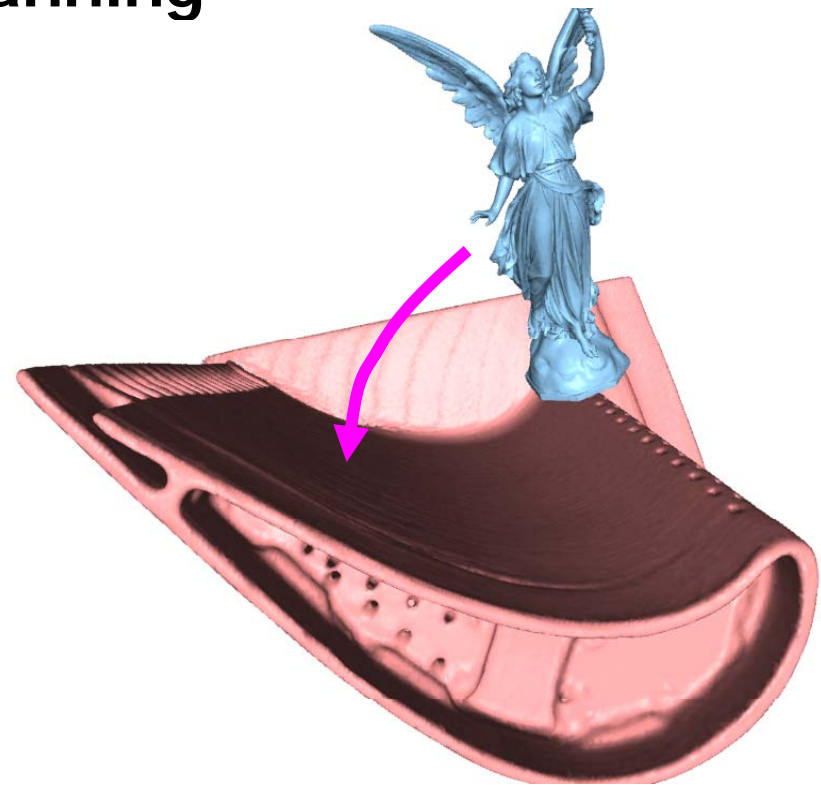


Colliding primitives



Collision Detection

- Main component of:
 - Dynamic simulation for game & movies
 - Navigation and path planning
 - Virtual prototyping

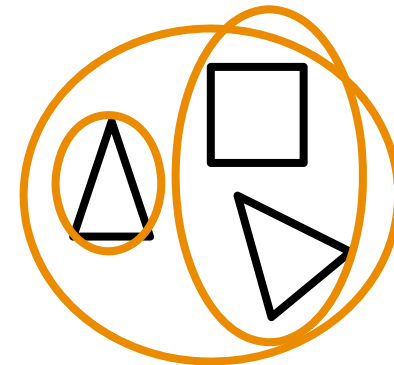
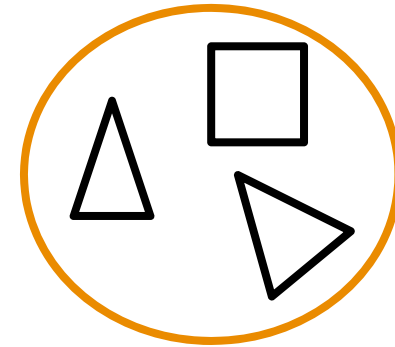


Time Complexity

- **Naive method between two objects**
 - $O(n * m)$, where n and m are # of triangles of two objects
 - Can be very slow even for small models
- **Can we do better?**
 - Employ culling techniques

Hierarchical Representations

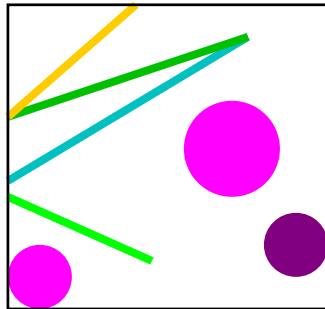
- **Bounding volumes**
 - A proxy containing primitives
 - Should be tight and easy to check for collision
 - Provide culling
- **Recursively represent models**
 - Provide hierarchical culling
 - Object partitioning hierarchies or space partitioning hierarchies



Object vs. Space Partitioning Hierarchies

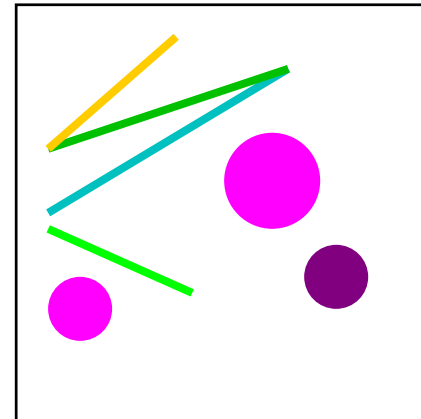
OPH:

- Object centric
- Spatial redundancy
- e.g., BVHs



SPH:

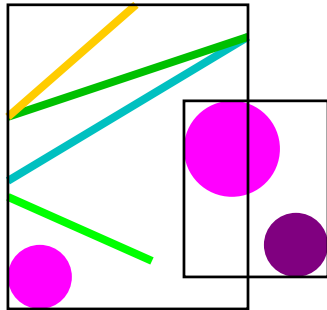
- Space centric
- Object redundancy
- e.g., kd-trees



Object vs. Space Partitioning Hierarchies

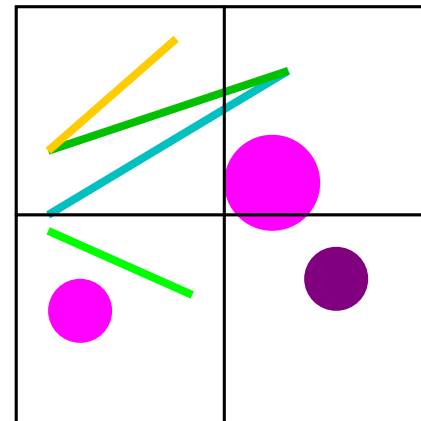
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SPH:

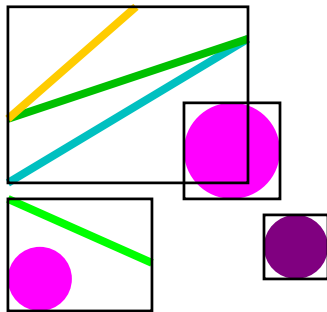
- Space centric
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Object vs. Space Partitioning Hierarchies

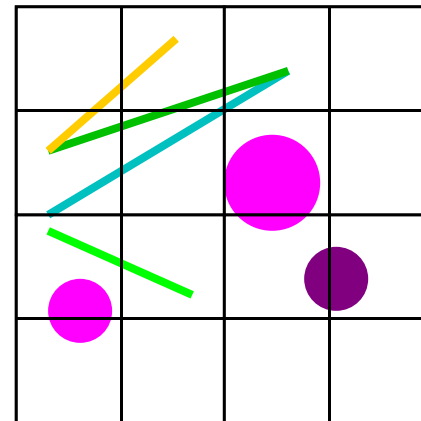
OPH:

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SPH:

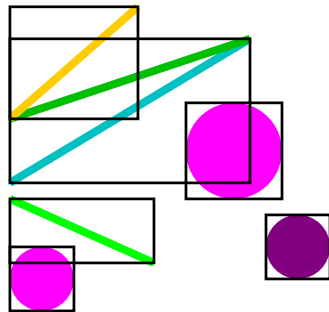
- Space centric
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- e.g., kd-trees



Object vs. Space Partitioning Hierarchies

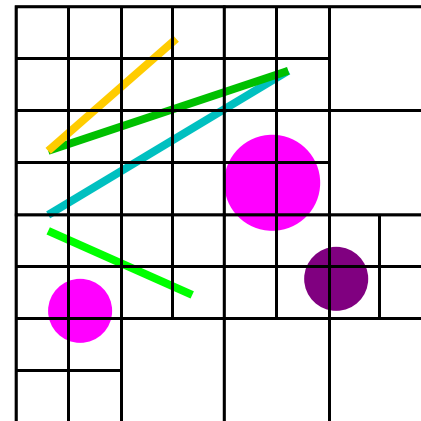
OPH:

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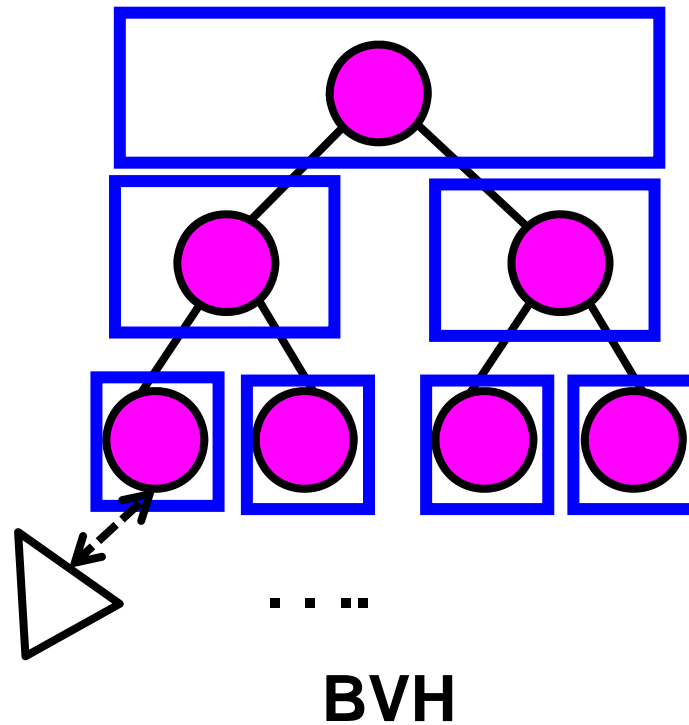
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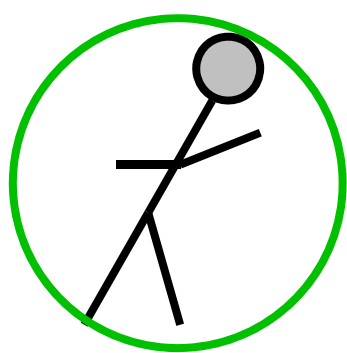


Bounding Volume Hierarchies

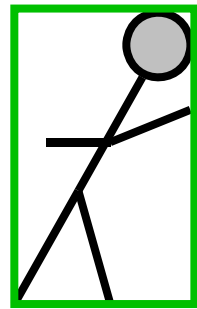
- Each node has bounding volumes
 - Leaf node has k primitives; typically, k is 1



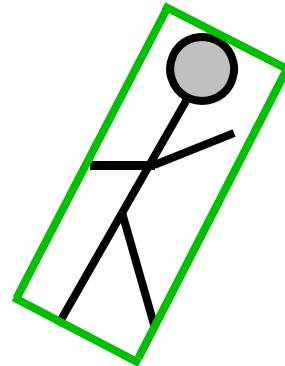
Trade-off in Choosing BV's



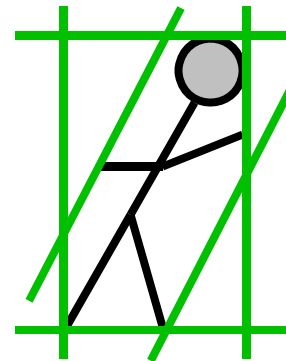
Sphere



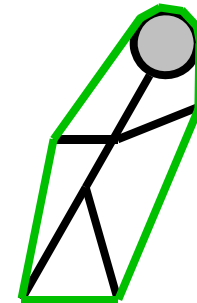
AABB



OBB



6-dop

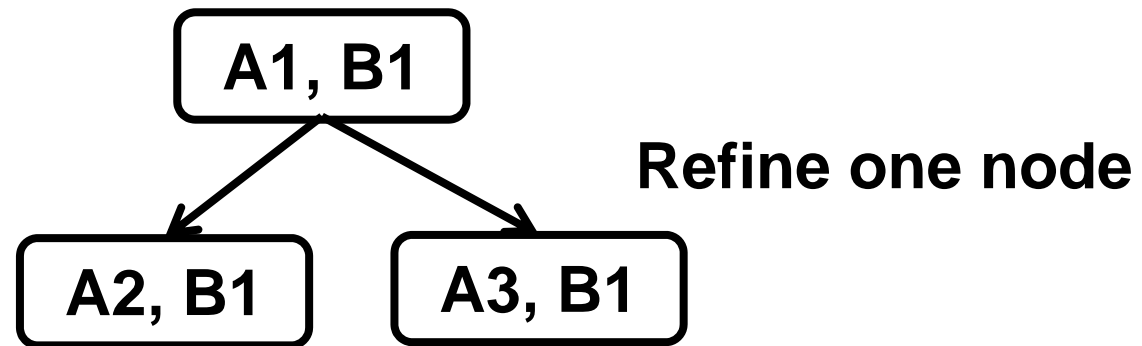
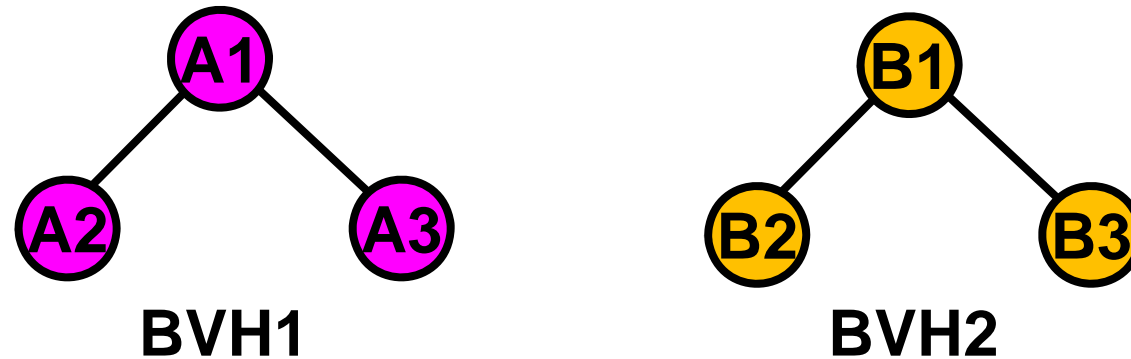


Convex Hull

→
increasing complexity & tightness of fit

←
decreasing cost of overlap tests + BV update

BVH-Based Collision Detection



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Bounding volume test tree (BVTT)

Hierarchy Construction

- **Top-down vs. bottom-up approach**
- **Top-down methods**
 - Recursively partition primitives into two subsets
- **Bottom-up methods**
 - Merges nearby primitives into BV nodes

Continuous Collision Detection

- Discrete checking
 - Can miss collision if time step is large
- Continuous checking
 - Always identify collisions
 - Expensive

