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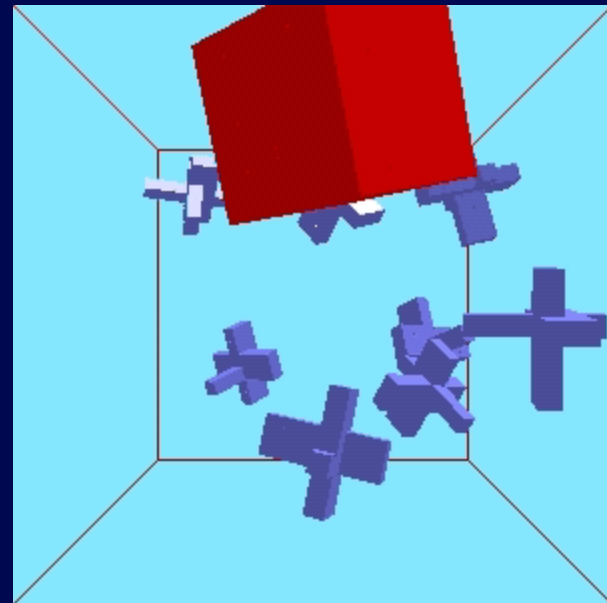
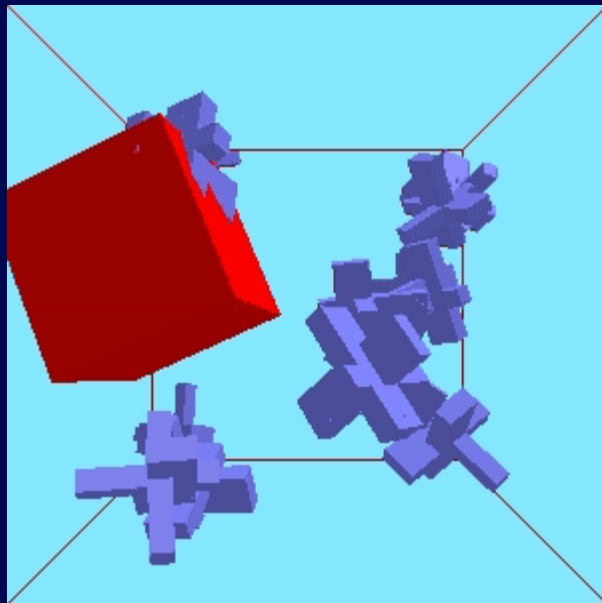
Collision Detection

Collision Detection



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Collision handling is fundamental to animation or dynamic scenes in virtual environments.



Applications



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- Games
- Simulation
 - Virtual Surgical
 - Vehicle Simulators
- Haptics
- Character Animation
- Molecular Modeling

Similarities in **Robotics**

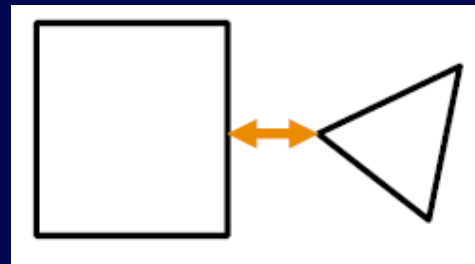
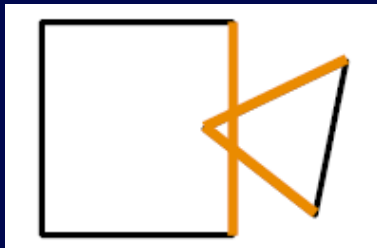


Two Issues

Collision Detection

Finding if the collision has occurred: Given two moving objects defined in an initial and final configuration, determine if they intersected at some point between the two states

→ geometric problem

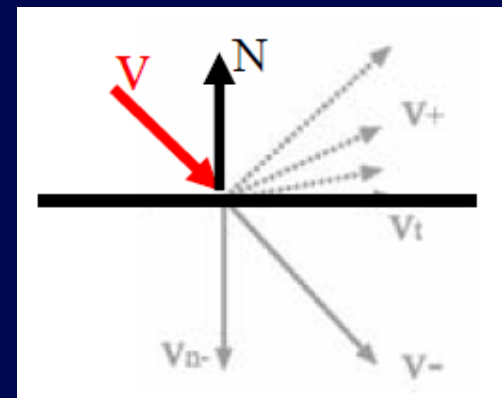
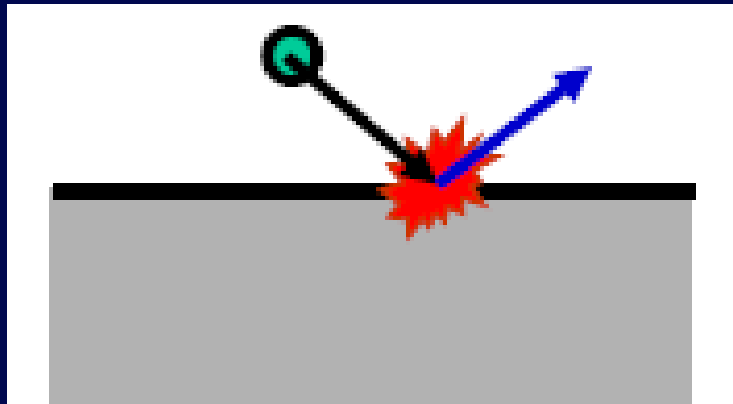




Two Issues

Collision Response

Finding the response after collision is found:
predicting behavior, may involve laws of physics



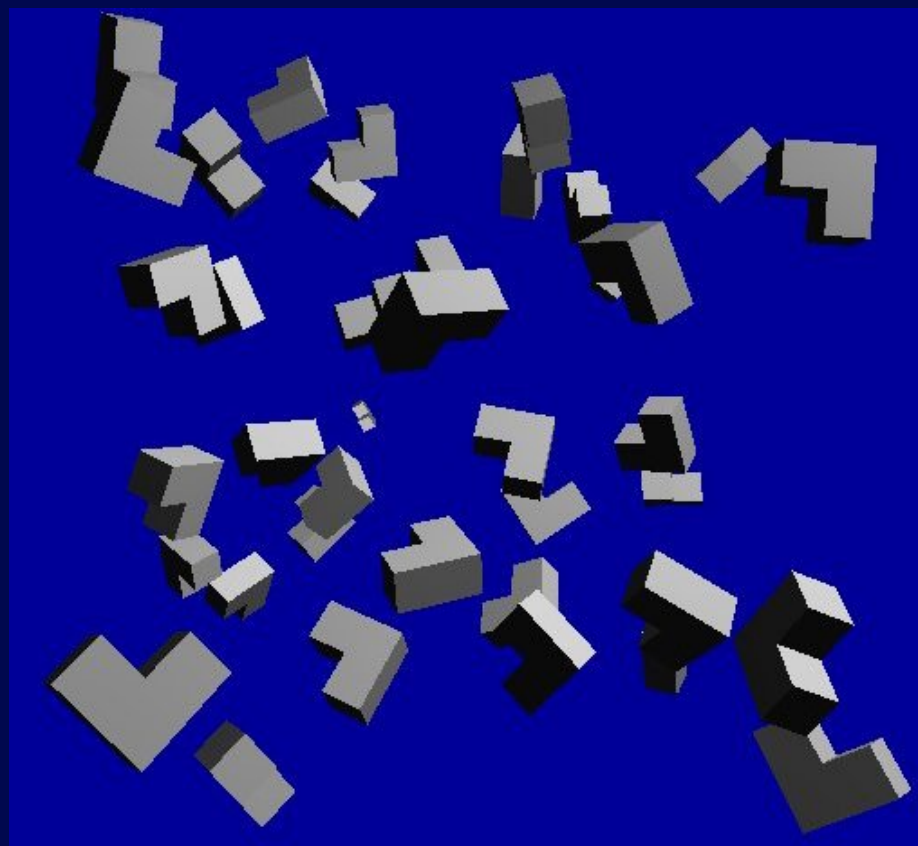
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Rigid Body Motion

Given N objects, finding collision is $O(N^2)$.



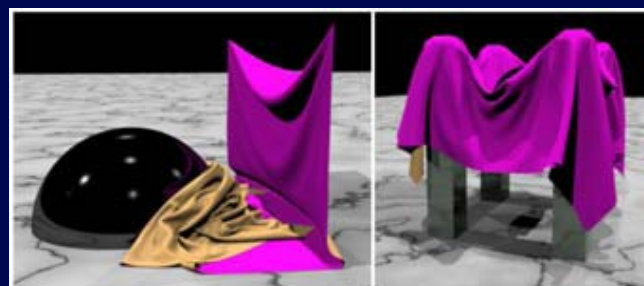
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Deformable objects

Object-object collision
Self collision



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Main Issues

Object-object intersection

Have seen some in Clipping, Occlusion

Computationally expensive

Optimization

Space partitioning

Object hierarchy

Reducing pair wise intersection (Hybrid approach)

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Type of Query

Boolean flag whether one is intersecting or not

Intersecting parts need to be found

Collision Detection



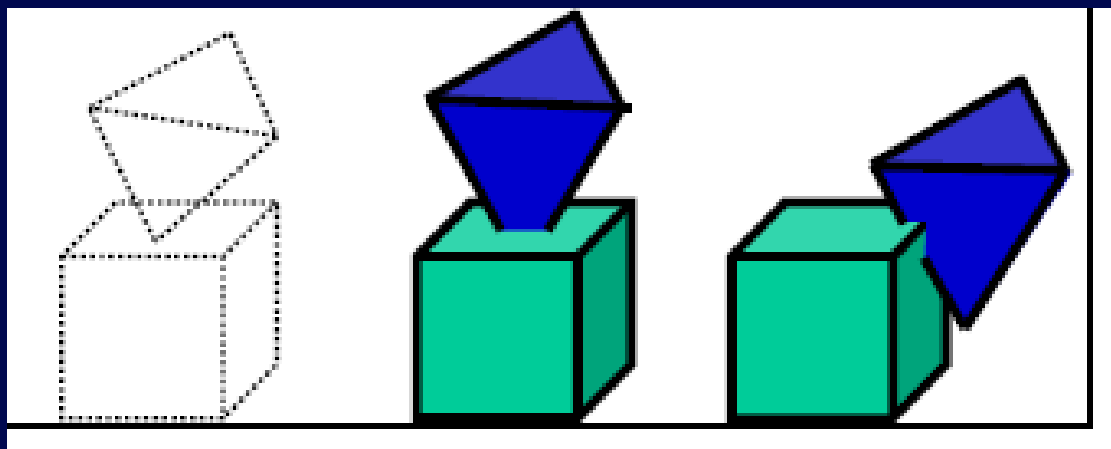
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Feature Approach

Two polyhedra.

Inside/outside test: vertex inside the polyhedra?

Edge to edge intersection



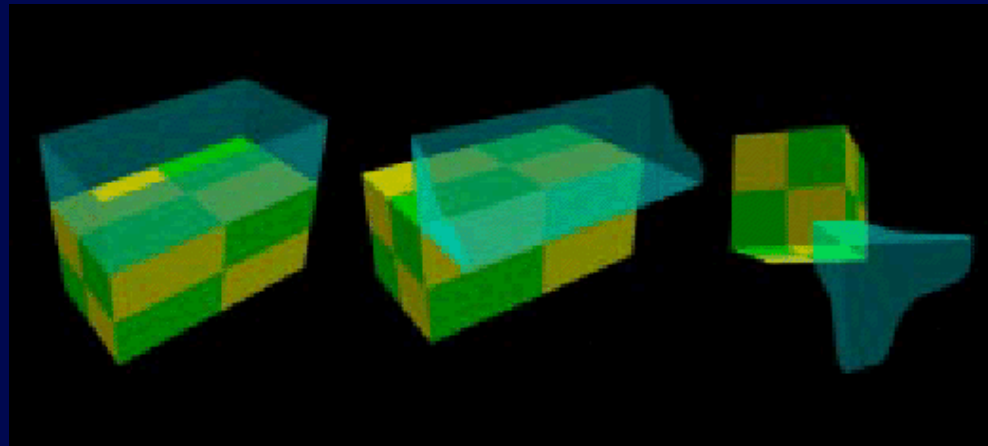
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Feature Approach

Mesh to mesh.



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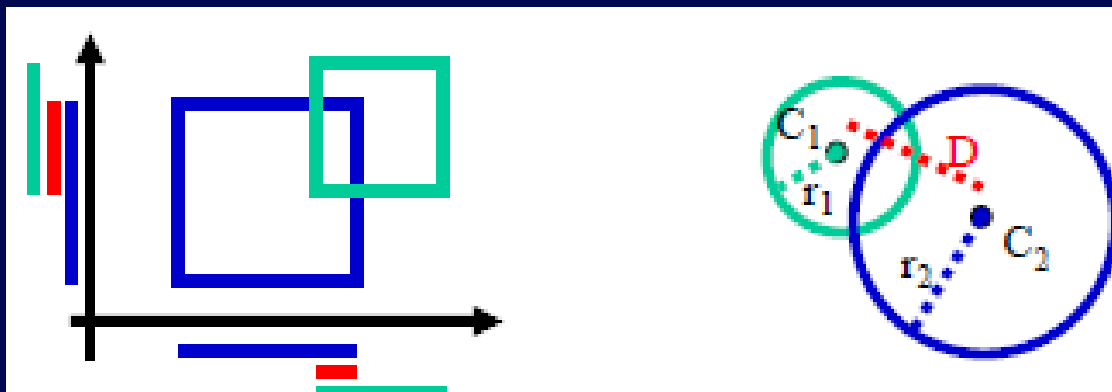
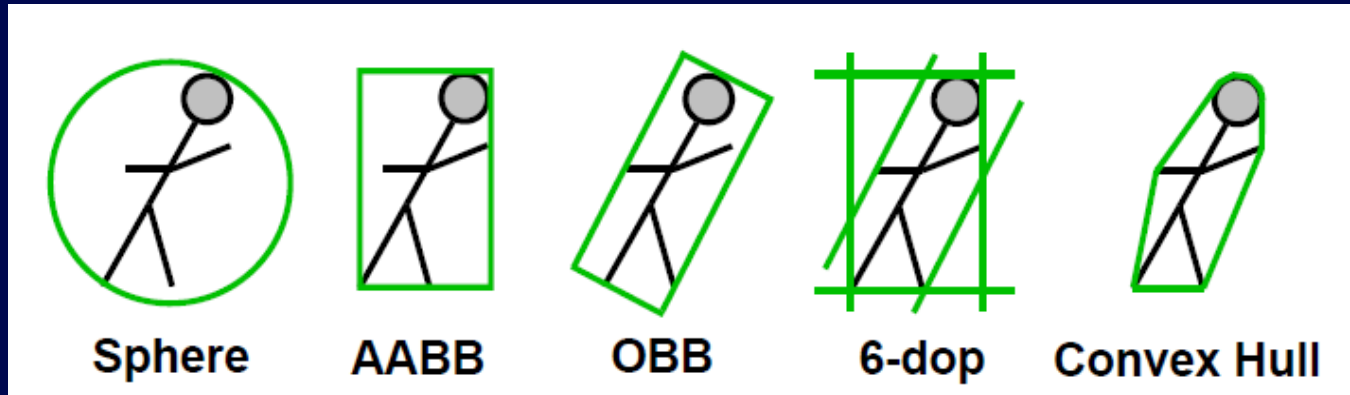
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Broad Phase Approach

Use of Bounding Volumes and Space Partitioning

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Bounding Volumes: Some examples



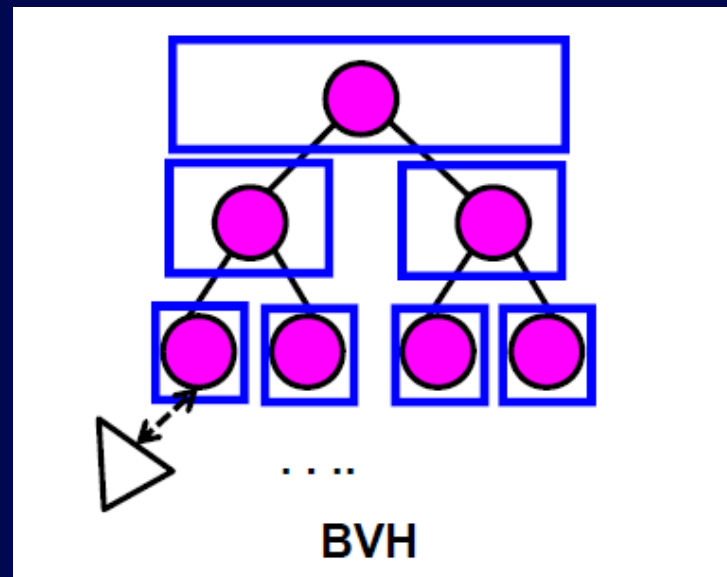
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Broad Phase Approach

Trees of bounding volumes are used, each level approximating the object.
(*Bounding Volume Hierarchy, BVH*)

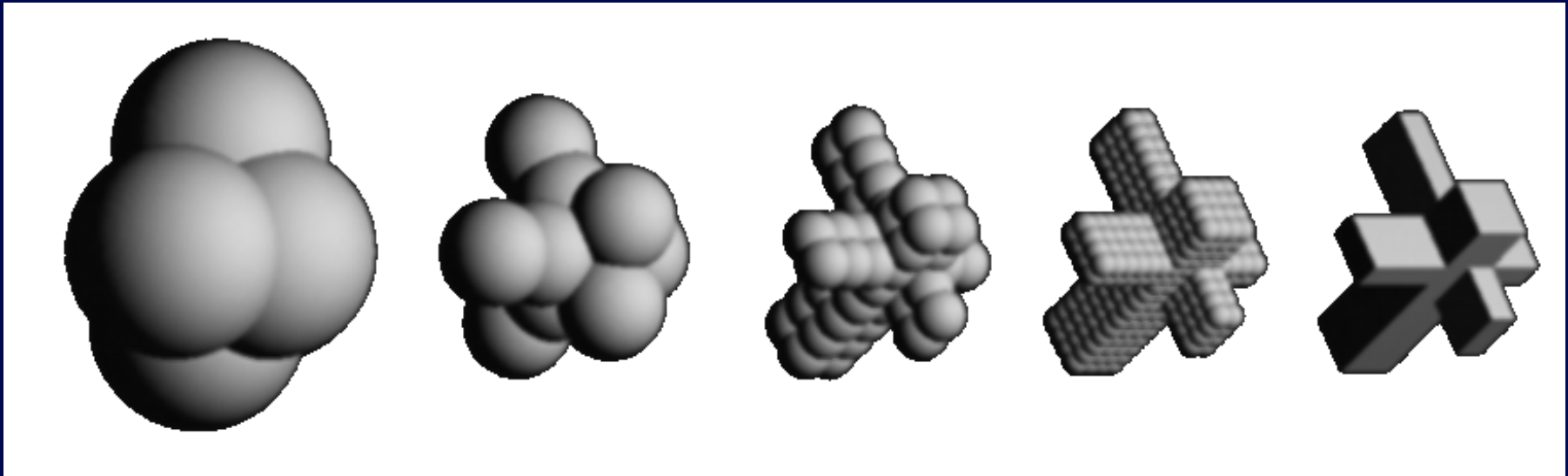
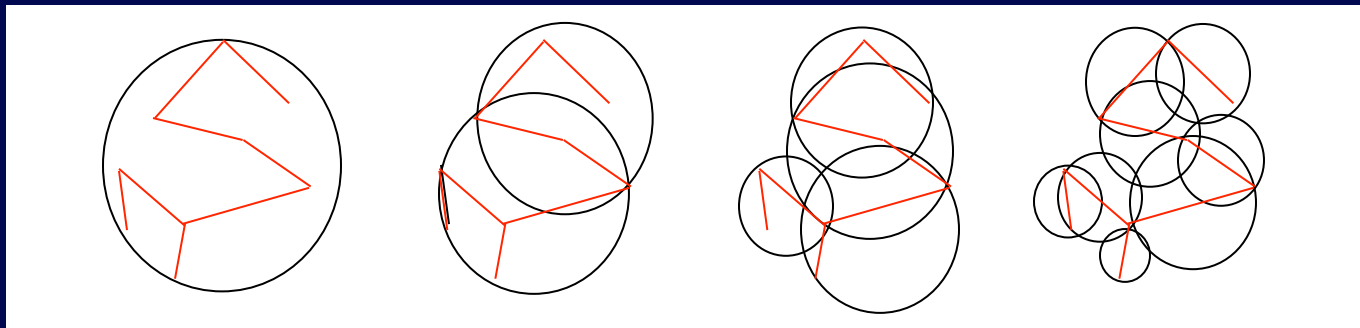


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Sphere Hierarchy

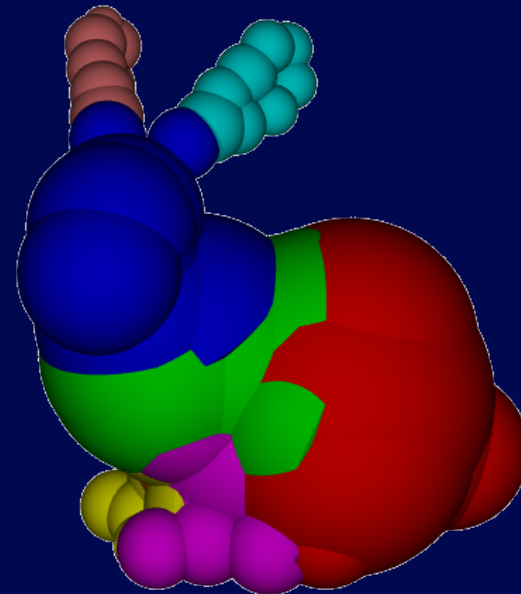
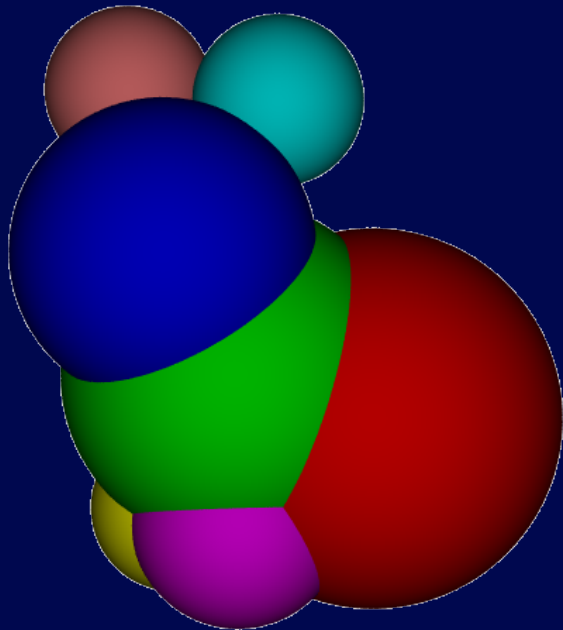


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Sphere Hierarchy

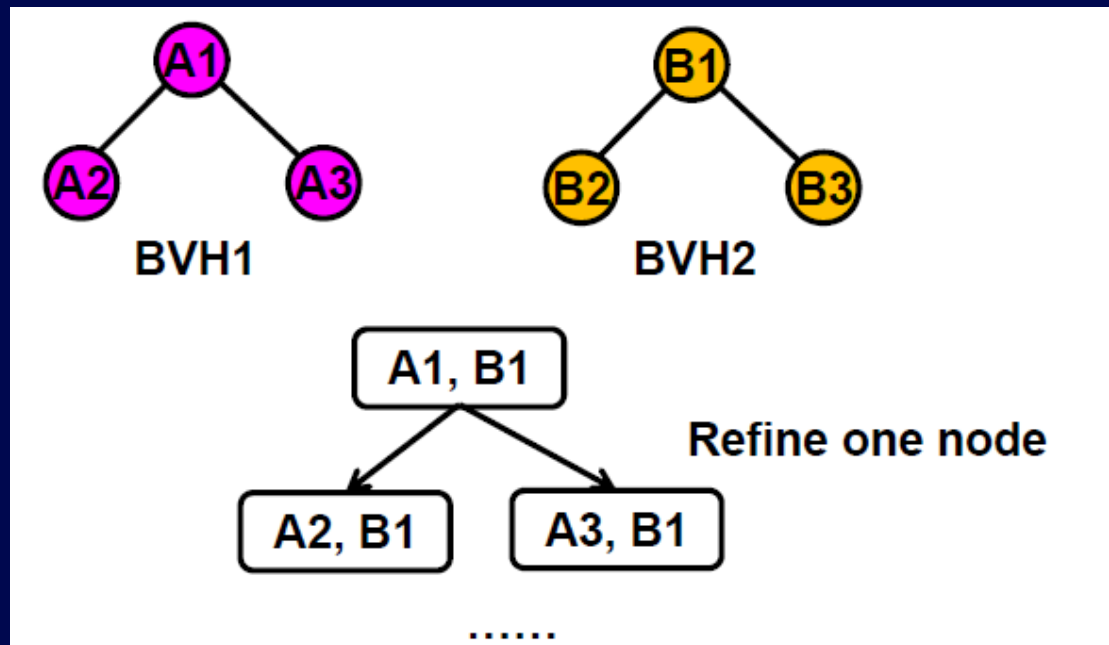


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Bounding Volume Based Collision Detection

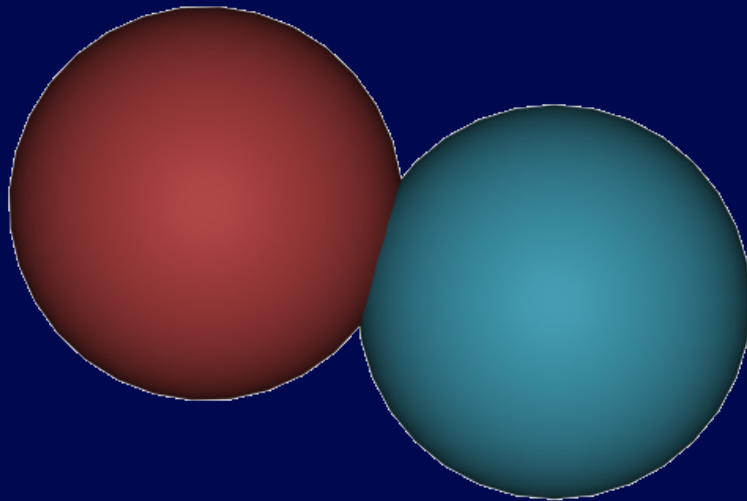


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Bounding Volume Based Collision Detection

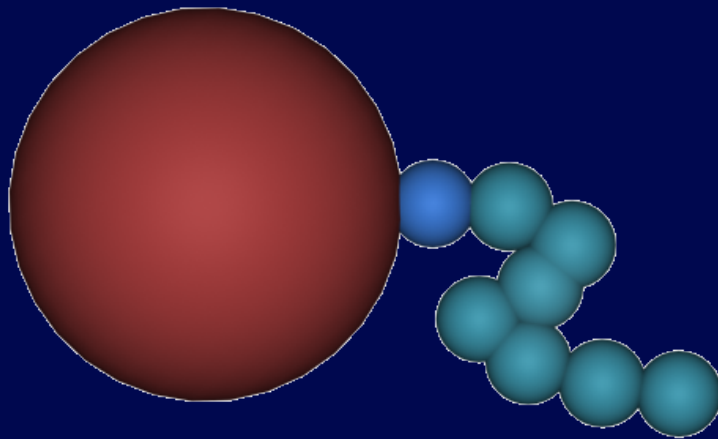


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Bounding Volume Based Collision Detection

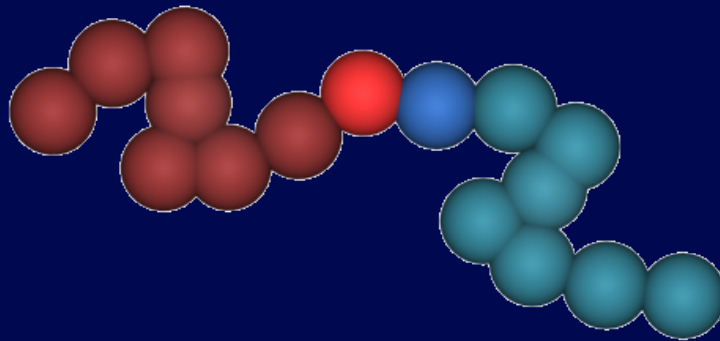


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Bounding Volume Based Collision Detection

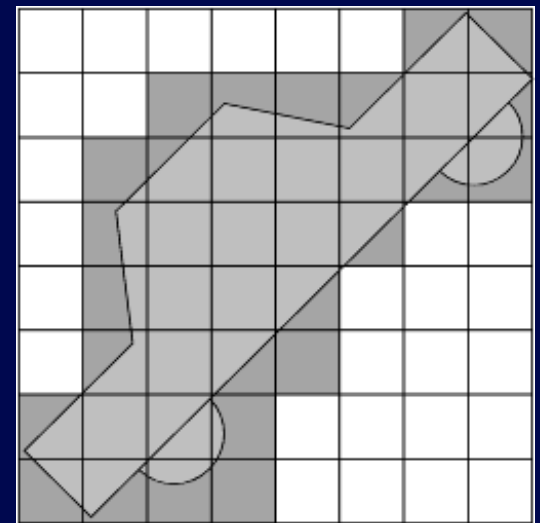
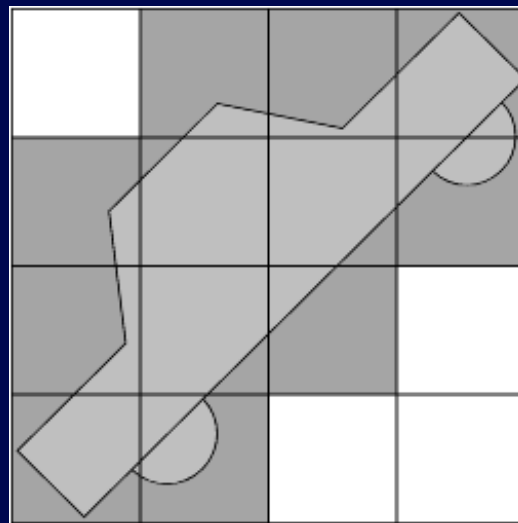
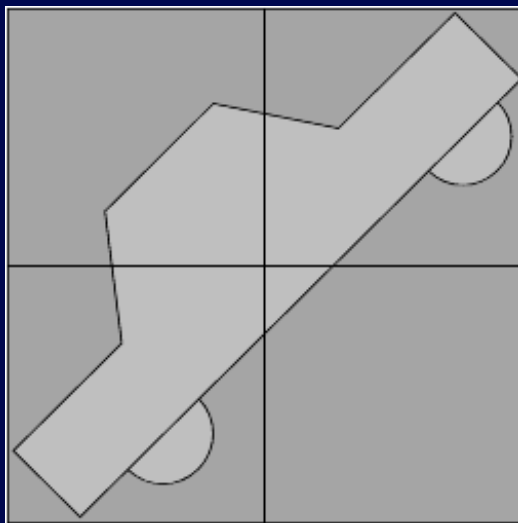


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Octree (Quad tree in 2D)

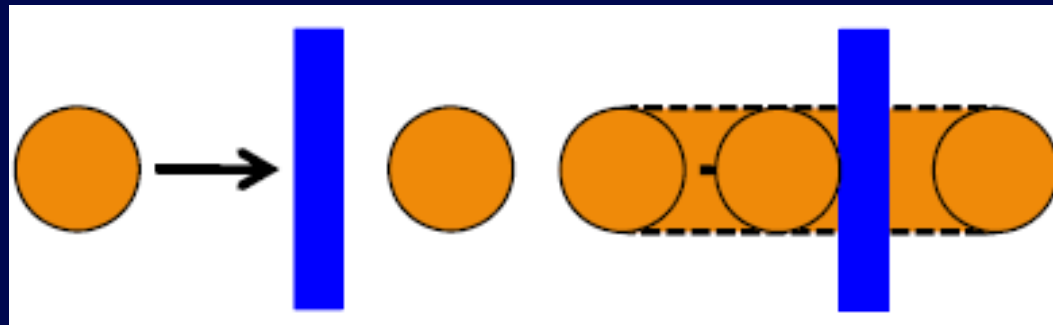


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Collision Detection: Time Step





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Thank You