PSE Game Physics

Session (4)
Coarse/Fine Collision tests, Collision: Sphere-Box, Box-Plane

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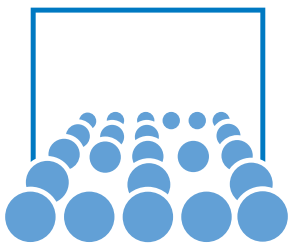

Outline

Collision detection

- Overview
- Bounding Volume Hierarchy (BVH)
- Coarse collision detection
- Fine collision detection

Collision: Sphere-Box

Collision: Box-Plane

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Overview

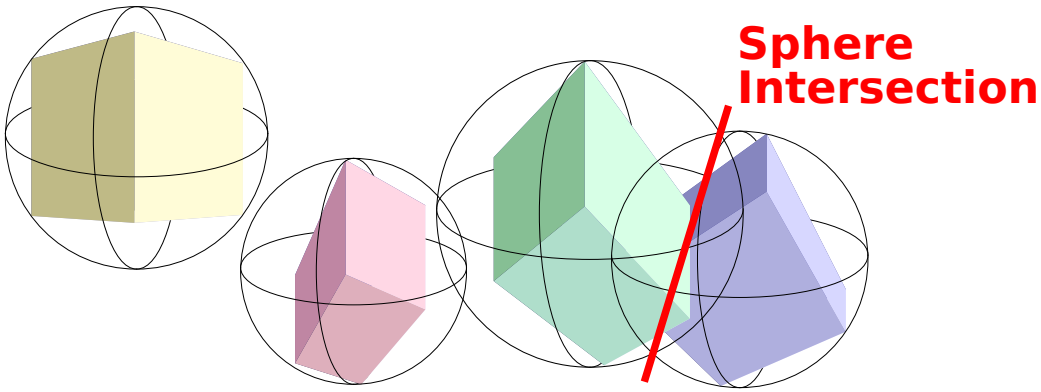
Collision detection is separated into several hierarchical passes:

- Bounding Volume Hierarchy (BVH) trees or similar structures
- Coarse collision detection
- Fine collision detection

Bounding Volume Hierarchy (BVH)

- When testing N objects for collisions with all other objects, we get a complexity of $O(n^2)$
- Using BVH's reduces this complexity:
  - Setting up a spatial hierarchy of objects takes $O(n \log n)$
  - Most objects are static $\Rightarrow$ **Reusage** of the tree is advantageous.
  - During movement of object and thus **removing/inserting nodes**, try to keep the tree **balanced**.
  - Testing for intersections is **reduced to objects in directly neighborhood**, only.
- Not implemented so far in engine $\rightarrow$ Final project?

Coarse collision detection



- Idea: Use **simple & fast** collision tests to avoid running time-consuming fine collision tests.
- Simple collision tests: Sphere-Sphere, Axis aligned bounding boxes (AABB), ...
- When creating a new factory, its **bounding sphere radius** is computed.
- The object's radius and position is used for such an **early-reject** to avoid complex collision tests.
- Already implemented in the skeleton of our Physics-Engine.

Fine collision detection

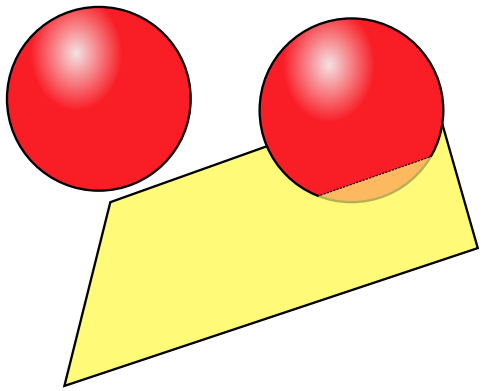


Figure: Example: Sphere-Plane collision

- **Accurate and time consuming** collision tests.
- In case of a detected collision, generates the collision data.
- Sphere-Sphere, Sphere-Box, Box-Box, ...
- ... the tests which are your task to implement :-)
- Further tests - e. g. for generic polygons - could be implemented in the final project.

Outline

Sphere-Box

- Can be handled similar to the sphere-plane collision test
- We **project** the Sphere to the model-space of the box
- Remember that collision checks are symmetric!
  $\Rightarrow$ Avoid checks by using the absolute values of the sphere's center coordinates.
- After testing plane intersections, also test edge and vertex intersections.

Outline

Box-Plane

- Our **non-infinite plane** is still an **artificial construct** used for limiting box-planes. Therefore we assume, that the size of a plane is larger than other physics primitives.
- Projecting the box to the model space of the plane simplifies many assumptions.
- Then the testing can be done a following:
  - Test whether all box **vertices** lie on one side, then no collision can be possible.
  - Otherwise, take the vertex with the **largest interpenetration** to get the collision data.
  - Take also **edge-edge** contacts into account!
- “Better” collision tests in the next session (*separating axes*)