

Bounding Volume Hierarchy

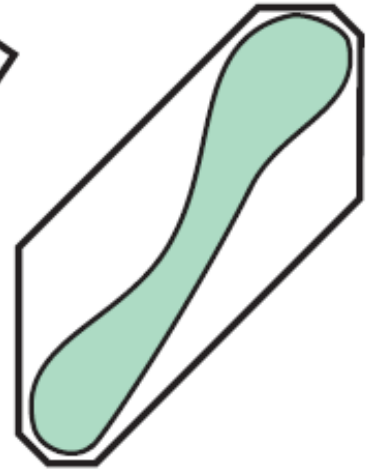
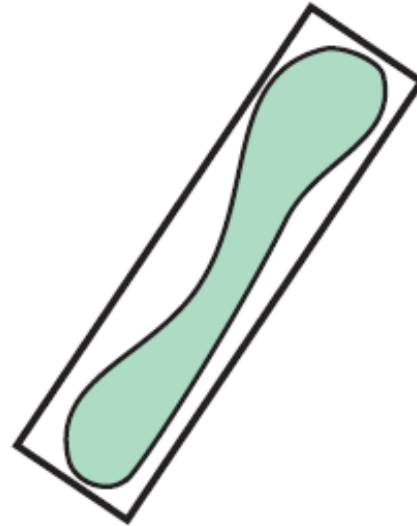
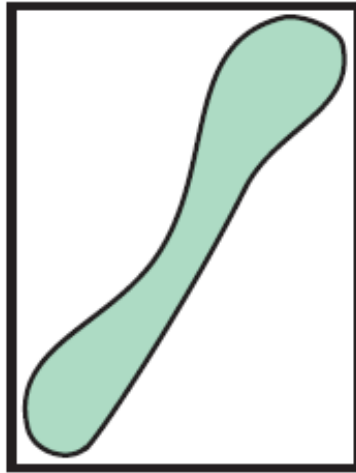
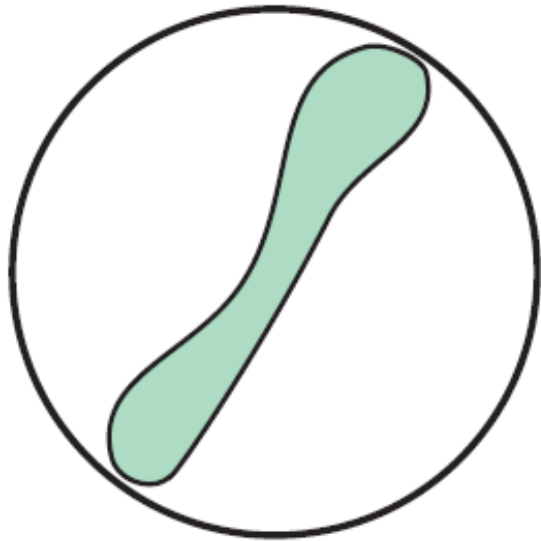
Myung-Soo Kim

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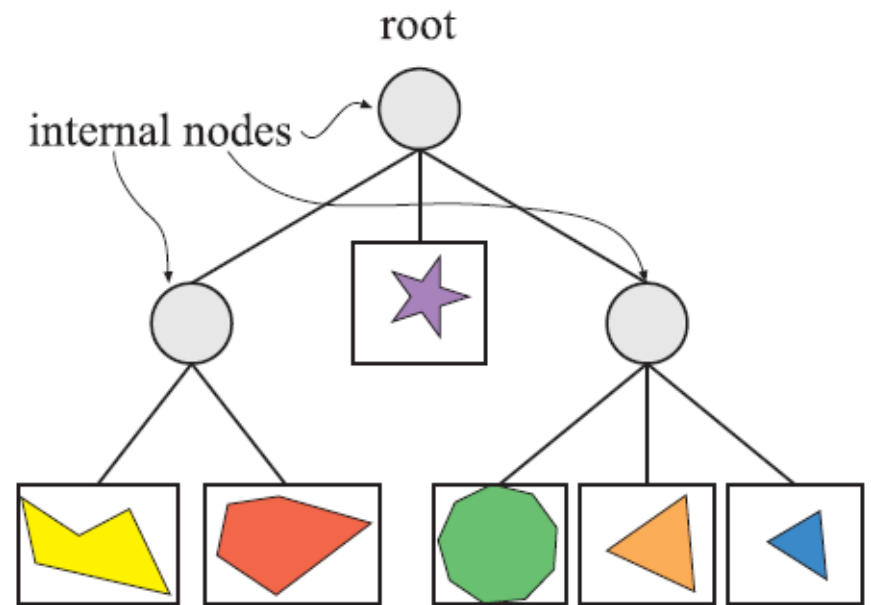
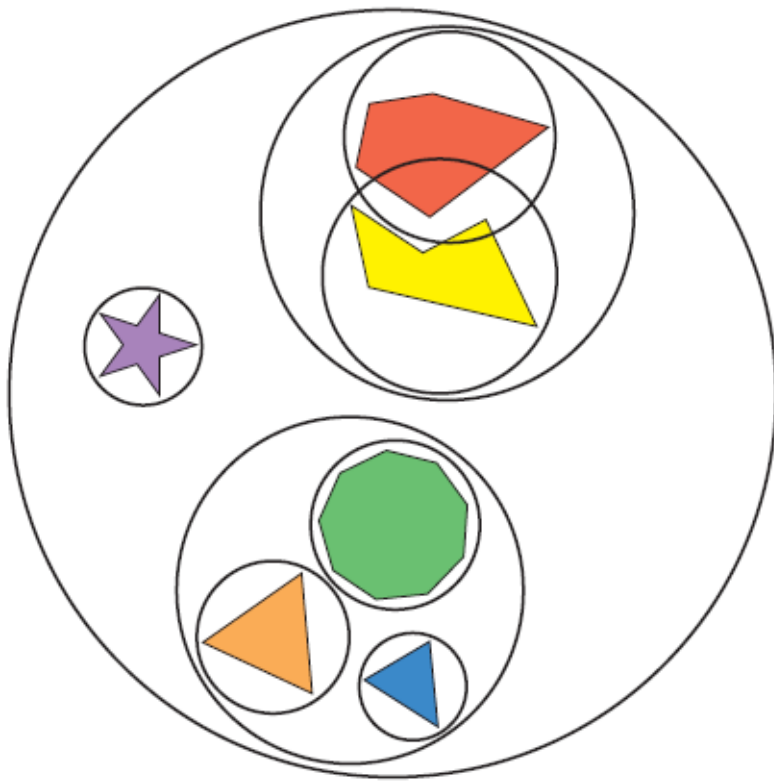
<http://cse.snu.ac.kr/mskim>

<http://3map.snu.ac.kr>

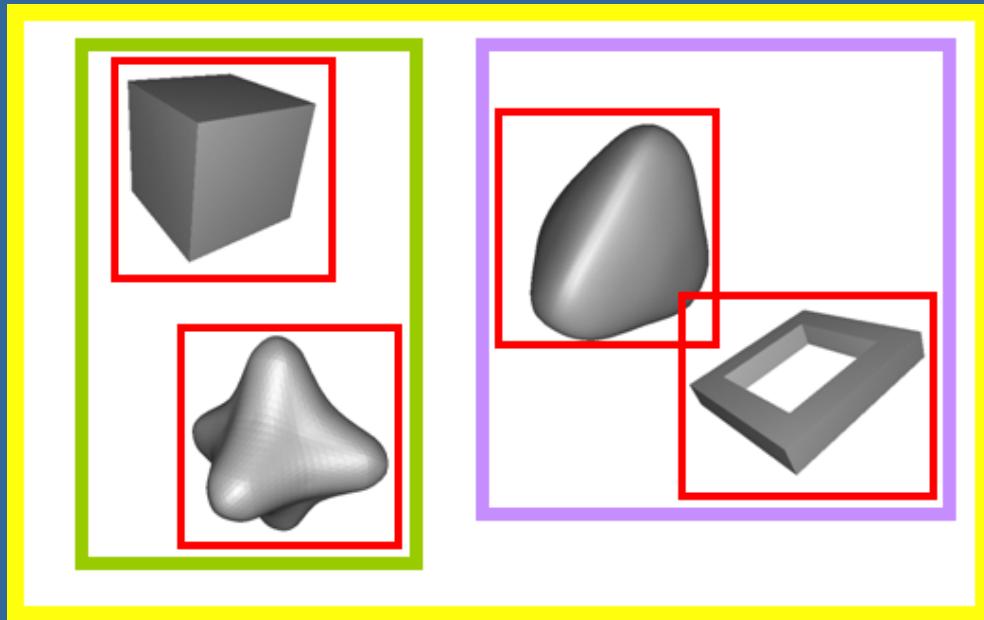
Bounding Volumes



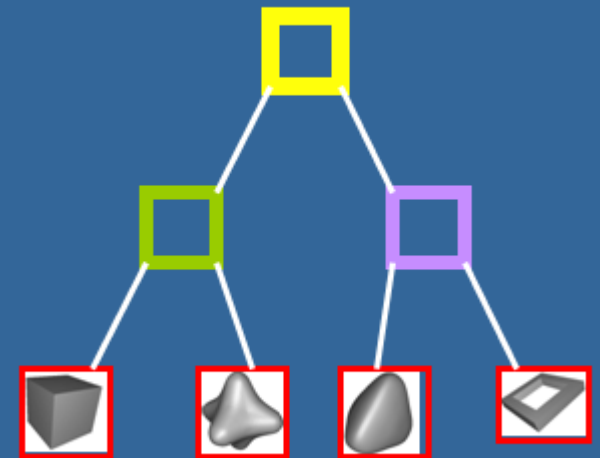
Bounding Volume Hierarchy



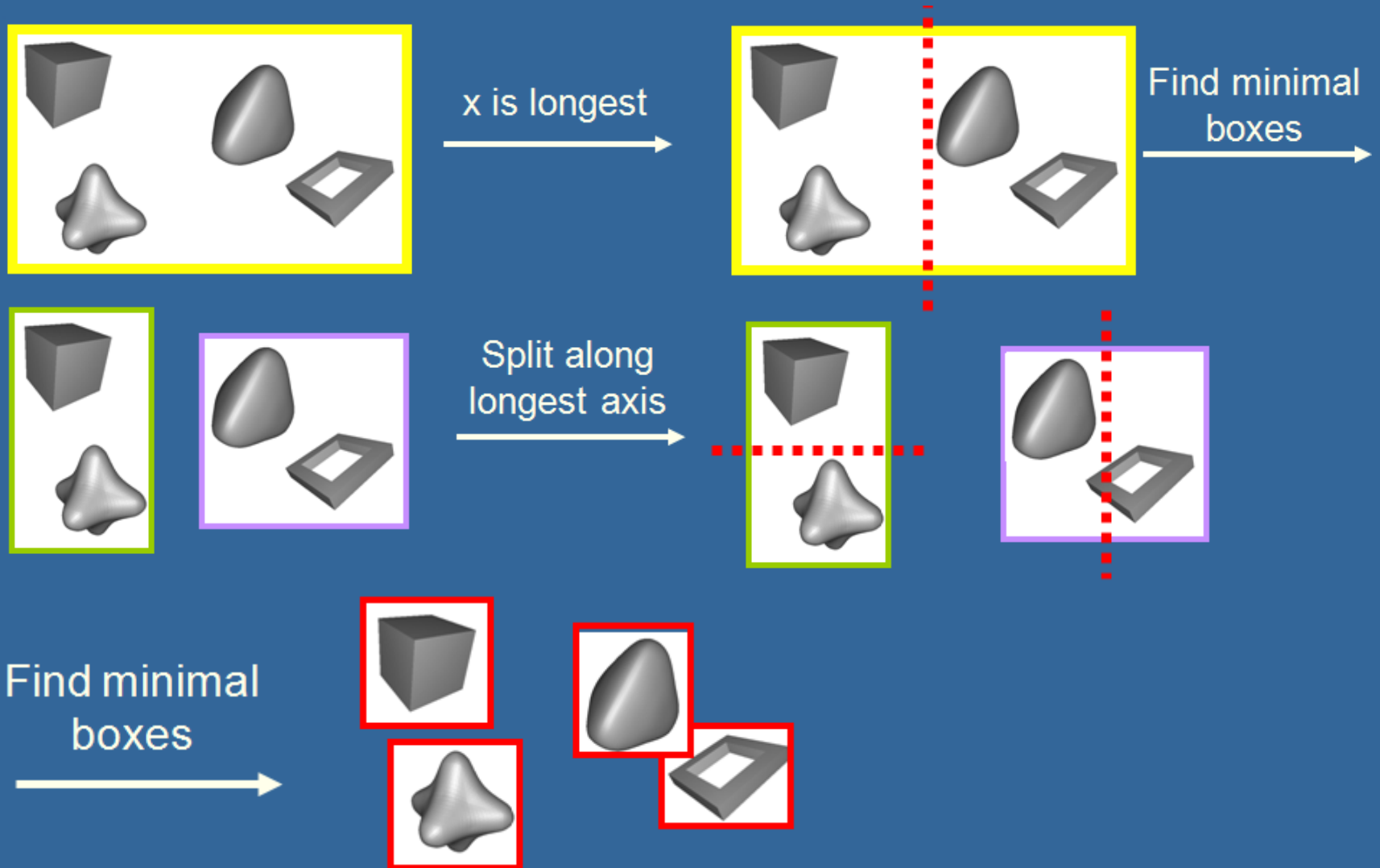
Bounding Volume Hierarchy



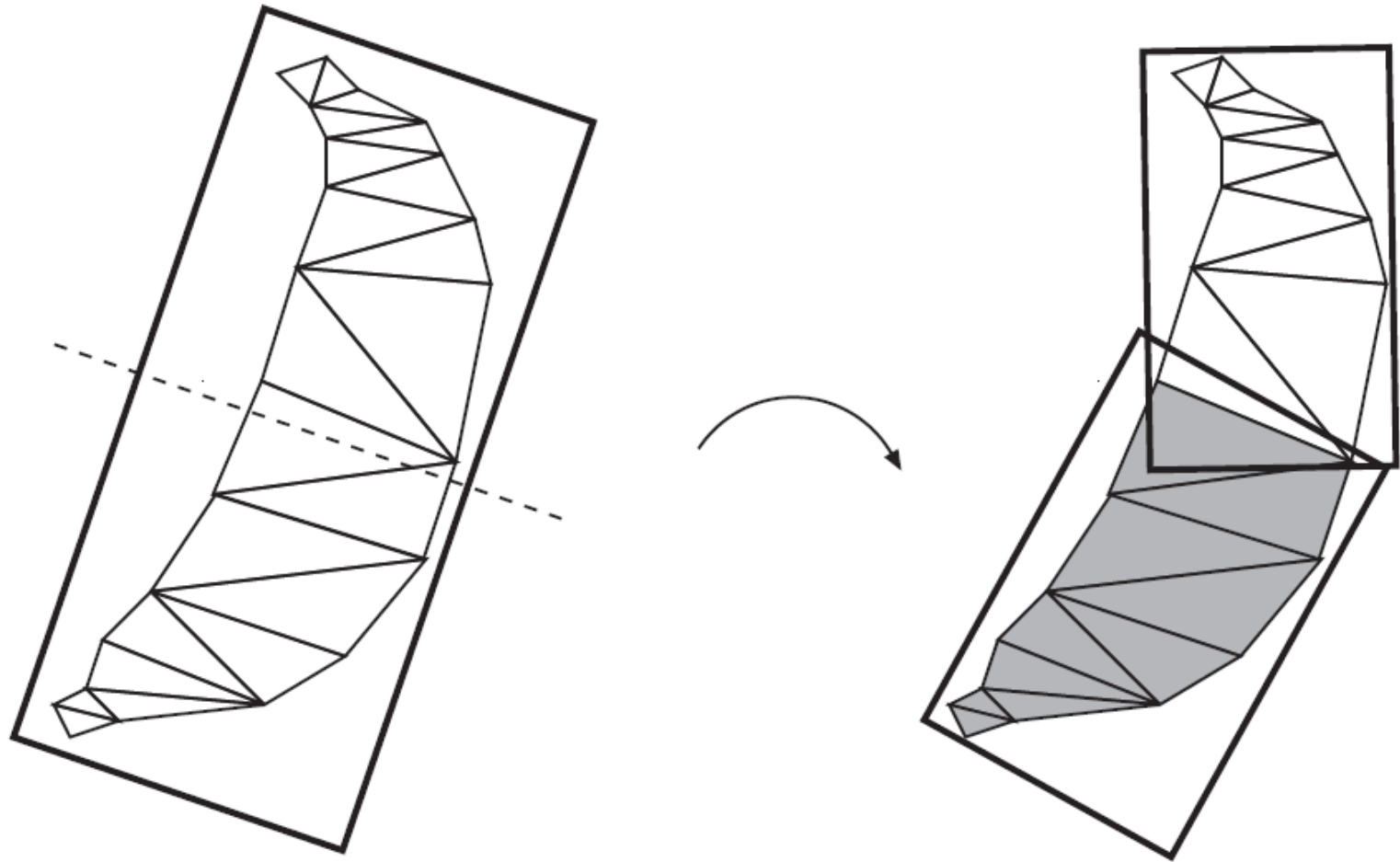
Data structure



BVH Construction for AABB



OBB Construction

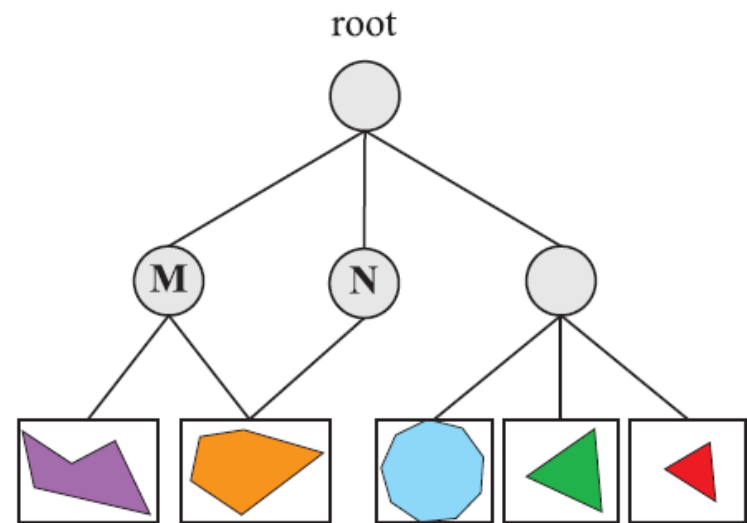
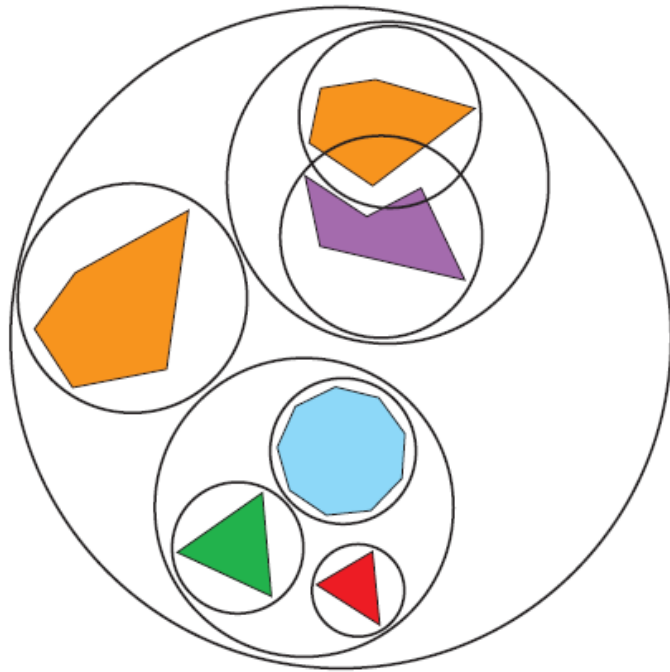


BVH Complexity

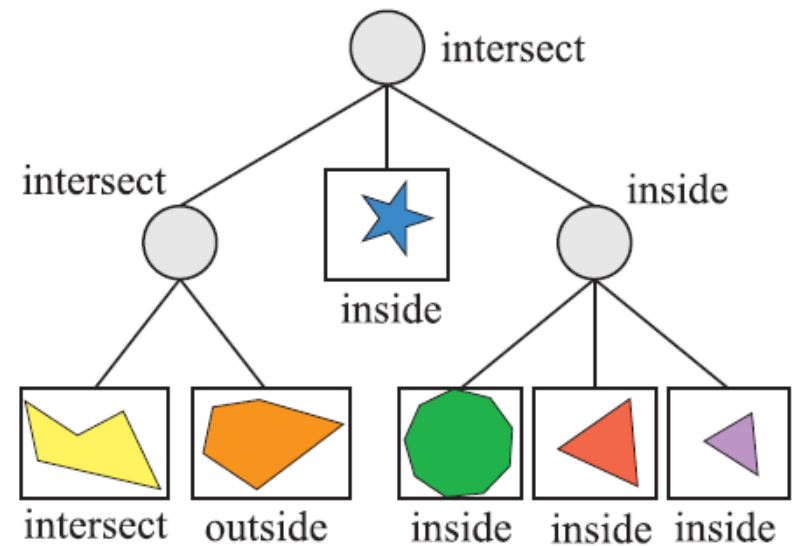
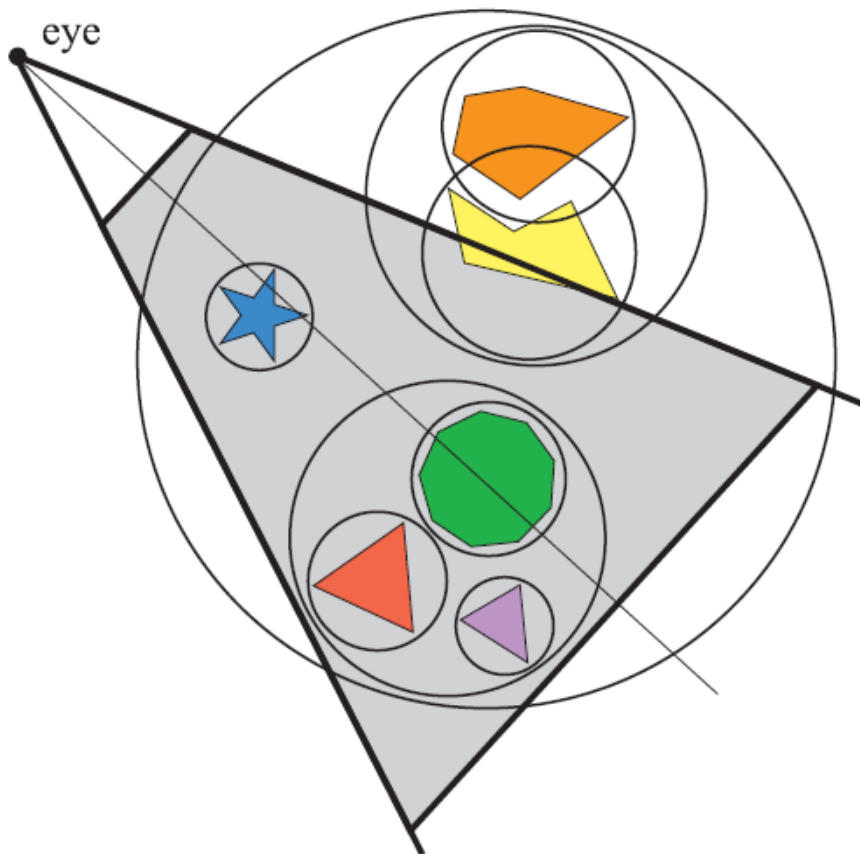
Model	Triangles (M)	Size of BVH (MB)	Mean and std of depth of leaves	Comp. time (min)
Hugo	0.02	2	16, 1.7	0.03
Bunny	0.07	8	17, 0.8	0.26
Dragon	0.8	108	21, 1.6	3
1M power plant	1.1	139	23, 2.9	6
Turbine	1.7	220	22, 0.7	8
Lucy	28	4,811	37, 3.4	34

Table 1: *Benchmark Models: Model complexity, sizes of BVHs, mean and standard deviation(std) of depth of leaf nodes, and computation time to compute cache-oblivious layouts are shown.*

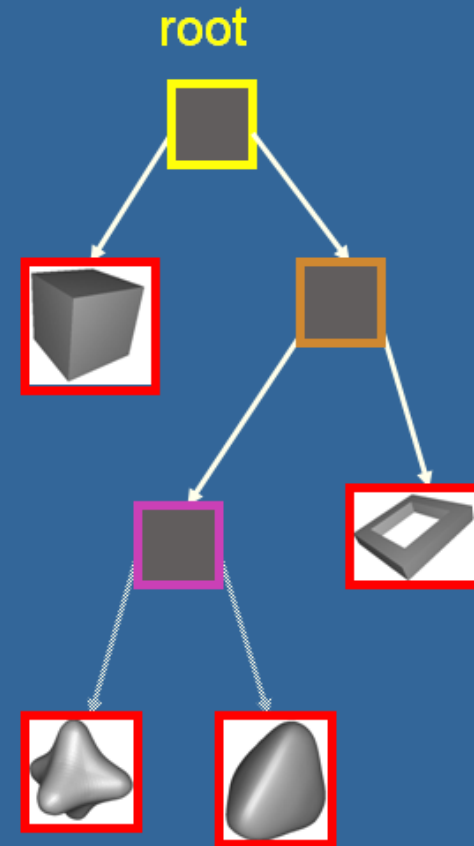
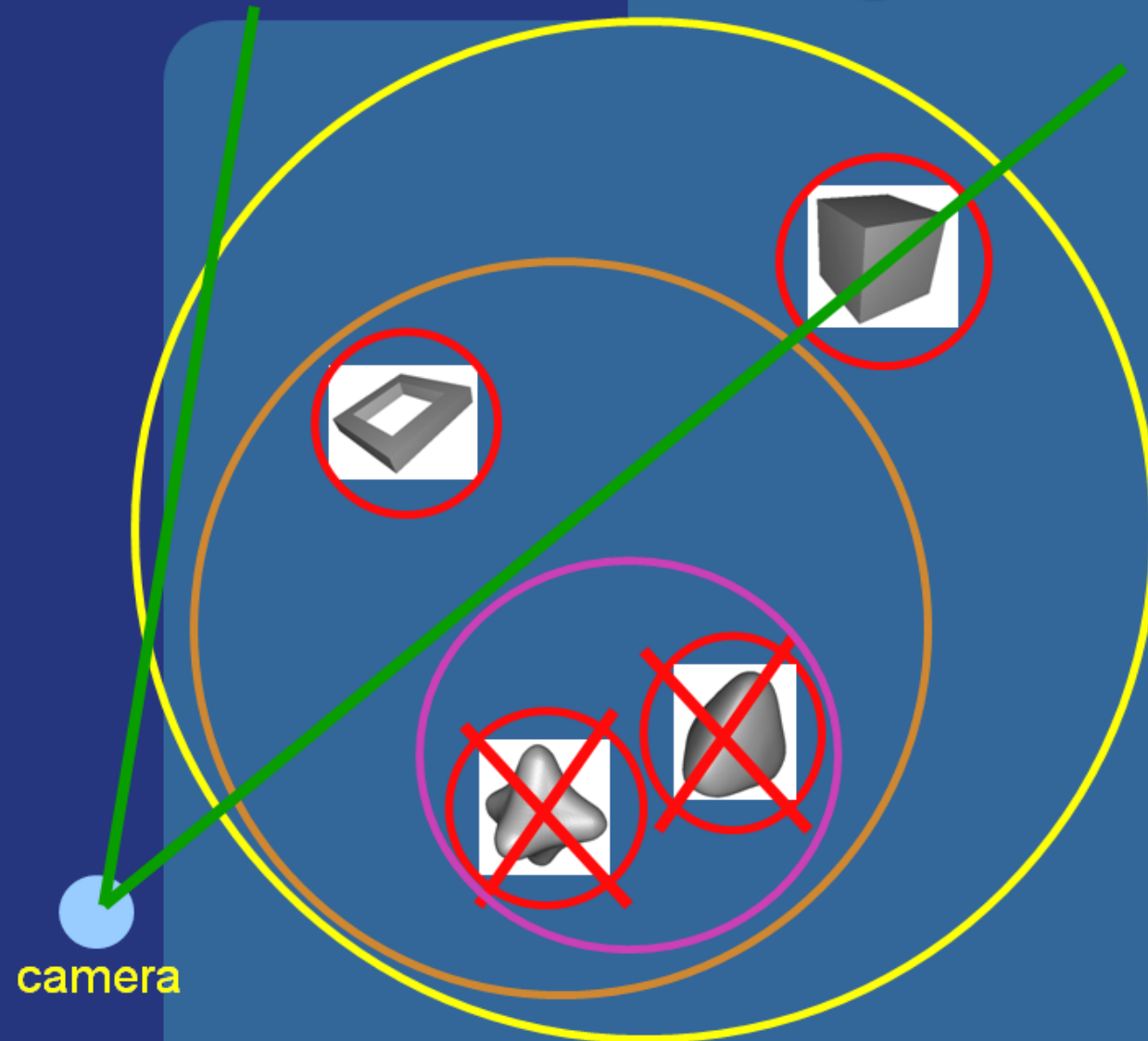
Scene Graph



View Frustum Culling



Example of Hierarchical View Frustum Culling



When $A = \{0\}$,

A and $B + \mathbf{p}$ intersect

$$\Leftrightarrow A \cap (B + \mathbf{p}) \neq \emptyset$$

$$\Leftrightarrow \mathbf{0} = \mathbf{b} + \mathbf{p} \text{ (for some } \mathbf{b} \in B \text{)}$$

$$\Leftrightarrow \mathbf{p} = -\mathbf{b} \in -B = \{-\mathbf{b} \mid \mathbf{b} \in B\}$$

When $A = \{\mathbf{a}\}$,

$$A \cap (B + \mathbf{p}) \neq \emptyset \Leftrightarrow \mathbf{a} = \mathbf{b} + \mathbf{p}$$

$$\Leftrightarrow \mathbf{p} = \mathbf{a} - \mathbf{b} \in \mathbf{a} - B = \{\mathbf{a} - \mathbf{b} \mid \mathbf{b} \in B\}$$

When $A = \{\mathbf{a}\}$,

$$A \cap (B + \mathbf{p}) \neq \emptyset \Leftrightarrow \mathbf{a} = \mathbf{b} + \mathbf{p}$$

$$\Leftrightarrow \mathbf{p} = \mathbf{a} - \mathbf{b} \in \mathbf{a} - B = \{\mathbf{a} - \mathbf{b} \mid \mathbf{b} \in B\}$$

When A is a set of points,

$$A \cap (B + \mathbf{p}) \neq \emptyset$$

$$\Leftrightarrow \mathbf{a} = \mathbf{b} + \mathbf{p} \text{ (for some } \mathbf{a} \in A \text{ and } \mathbf{b} \in B)$$

$$\Leftrightarrow \mathbf{p} = \mathbf{a} - \mathbf{b} \in A - B = \{\mathbf{a} - \mathbf{b} \mid \mathbf{a} \in A, \mathbf{b} \in B\}$$

Minkowski Sum/Difference

$$A + B = \{a + b \mid a \in A, b \in B\}$$

$$A - B = \{a - b \mid a \in A, b \in B\}$$

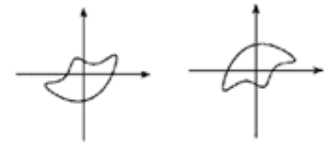
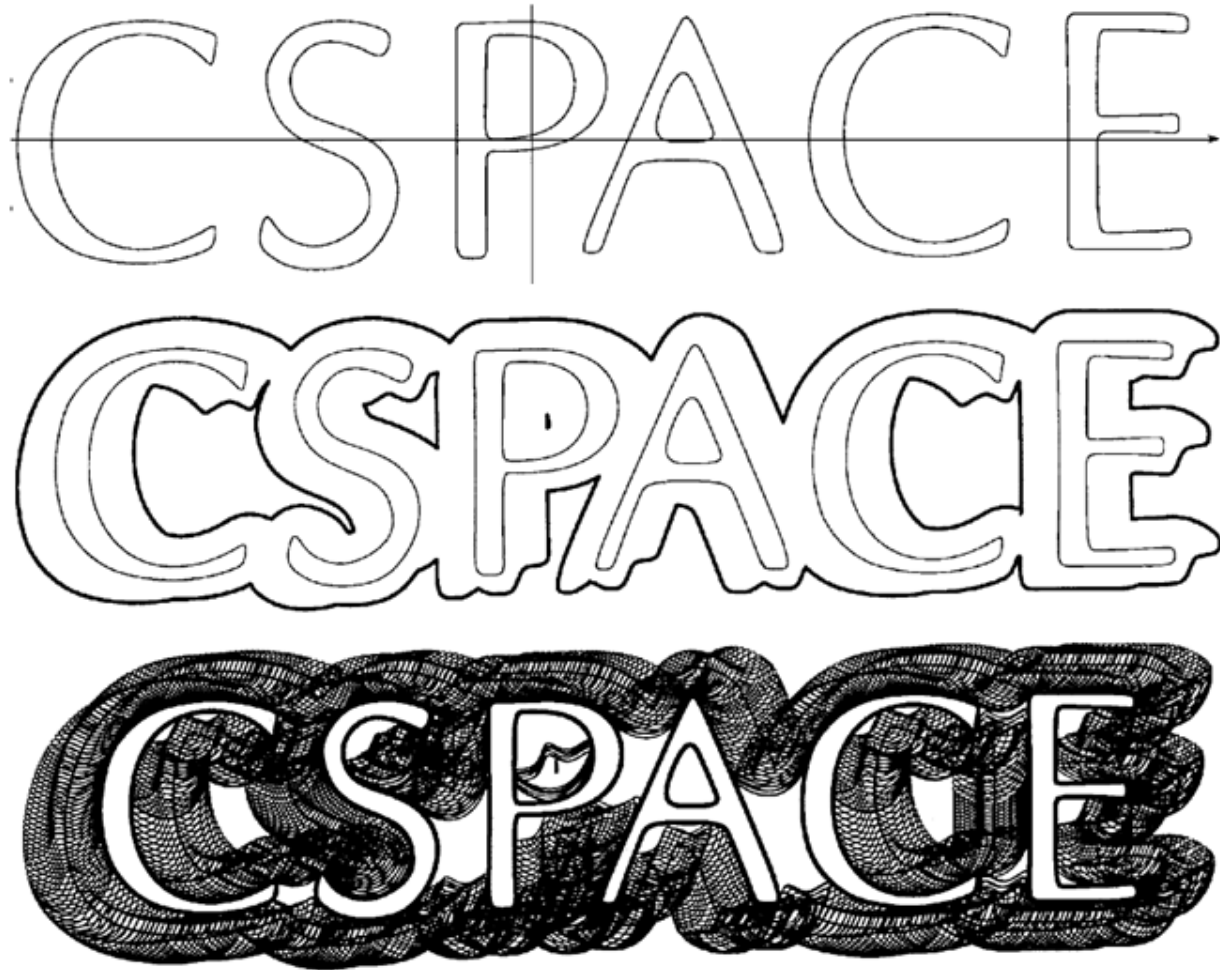
$$A \cap (B + p) \neq \emptyset$$

$$a = b + p$$

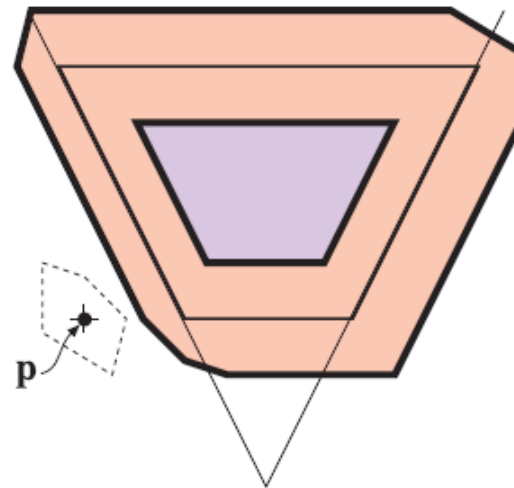
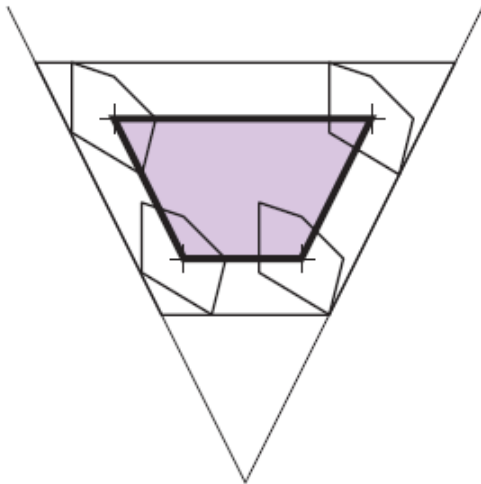
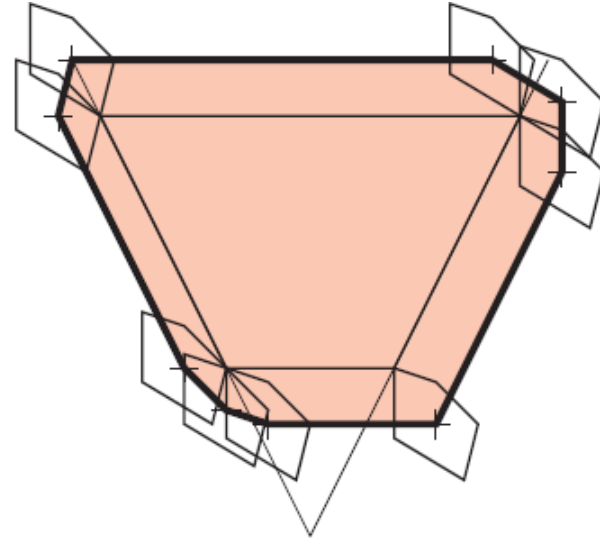
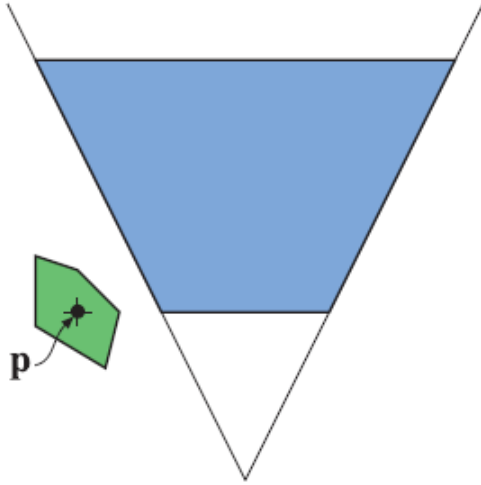
$$p = a - b$$

$$p \in A - B$$

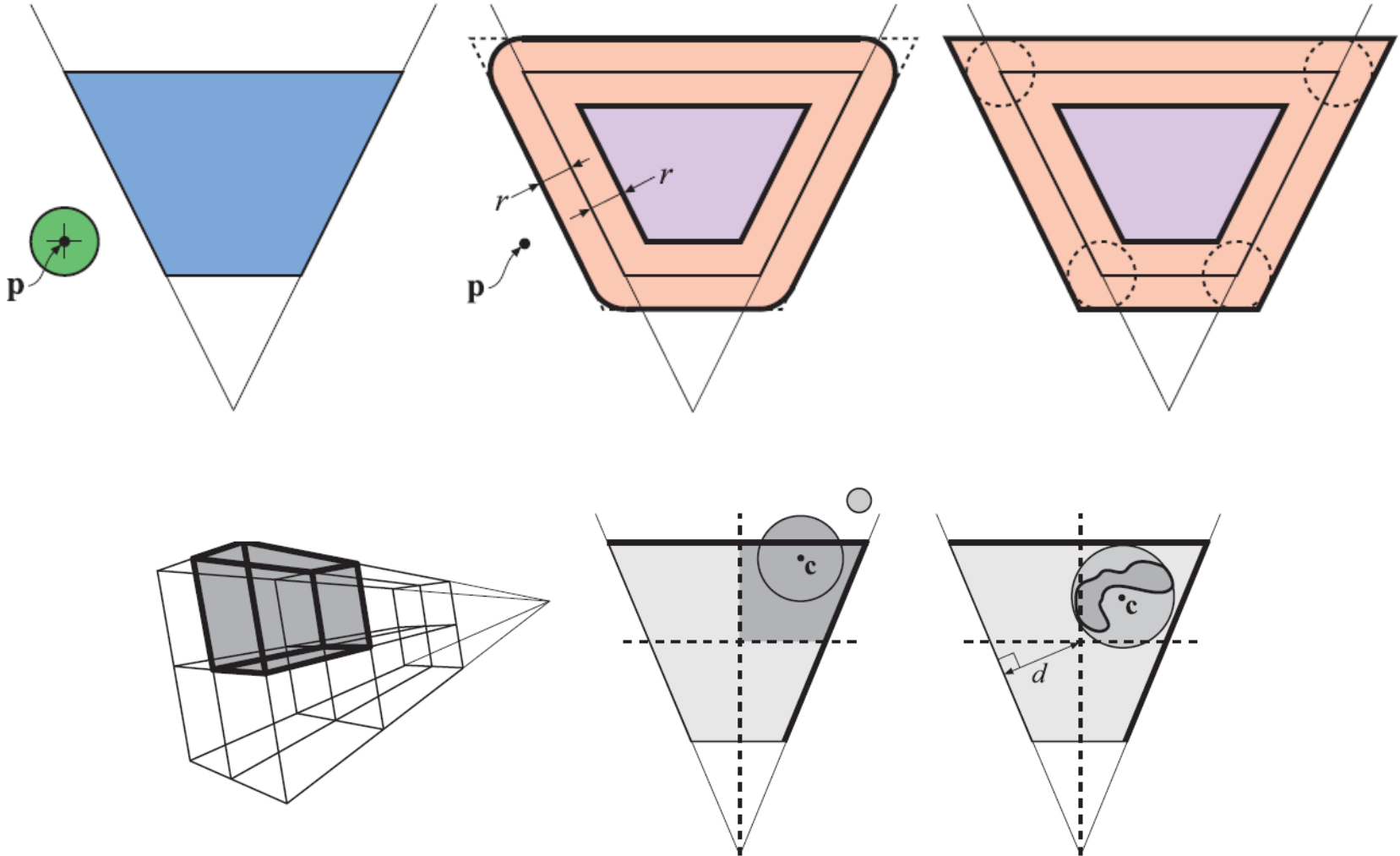
Collision-Avoidance Motion Planning



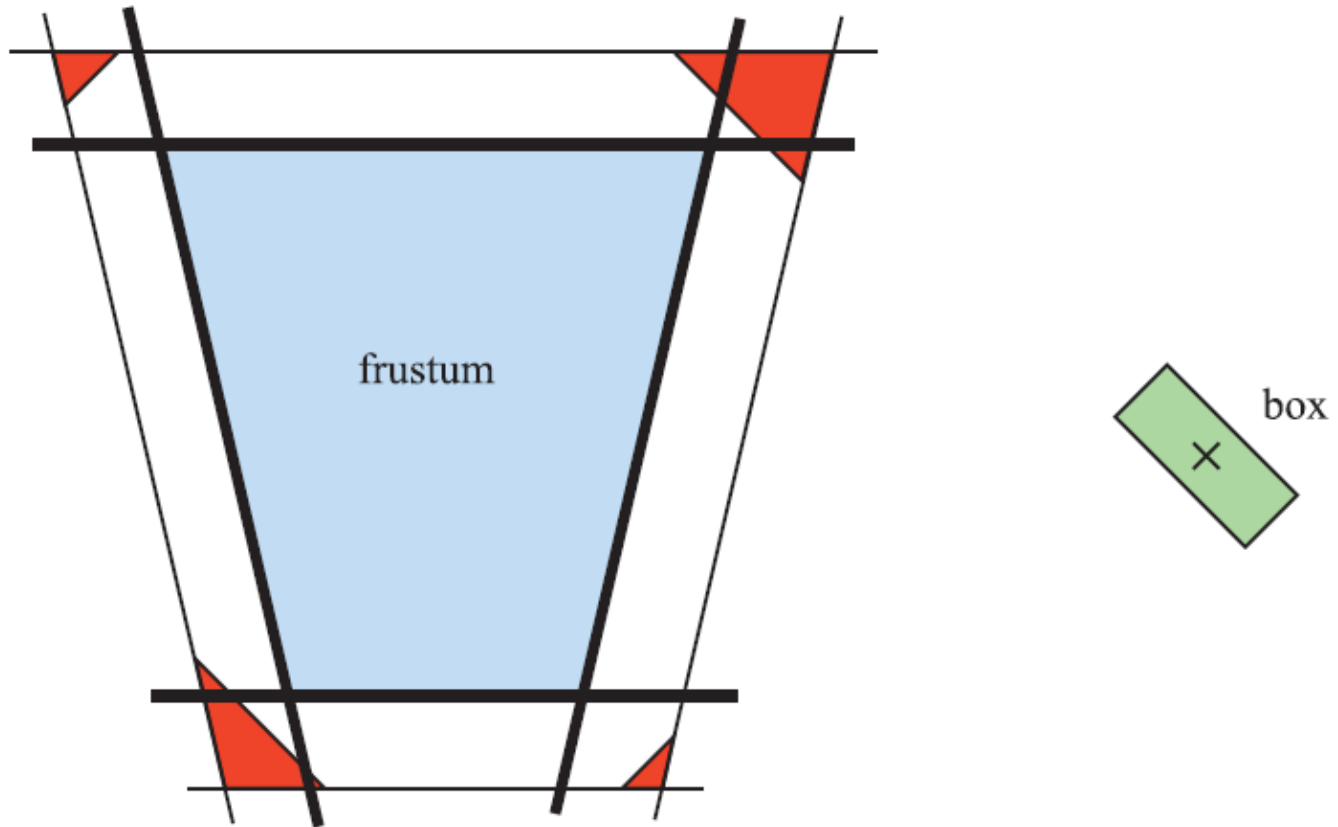
View Frustum Intersection



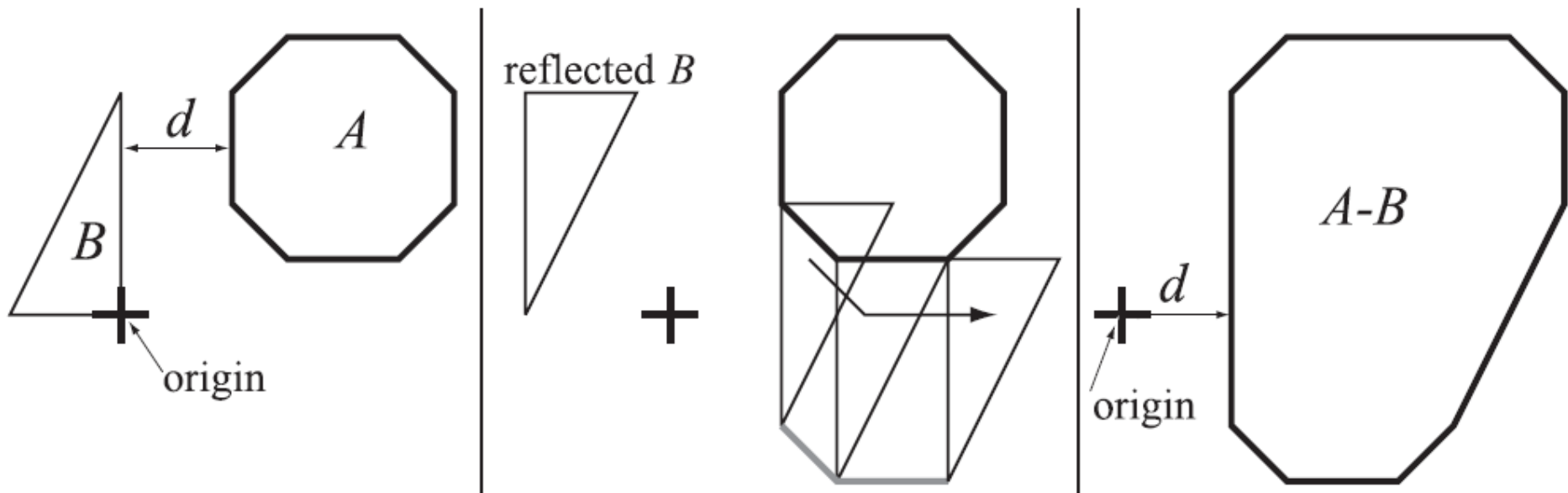
View Frustum Intersection



Frustum/Box Intersection



Distance Queries



$$A-B = \{a-b \mid a \in A, b \in B\}$$

GJK Algorithm for Convex Obj.

