# CS 7491 Notes: Interference

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**1.** Vocabulary

A *vertex* is a point in space. An *edge* is a line segment connecting two vertices without boundary (two end points). A *triangle* is a region bounded by 3 edges without boundary (three edges and three vertices). The *closure* of a set $A$ is closure$(A)$ = $A \cup$ boundary$(A)$. *Interference* between two polyhedra $A$ and $B$ has occurred if interior$(A) \cap$ interior$(B) \neq \emptyset$, that is, $A \cap B$ has positive volume. *Contact* has occurred if $A \cap B$ = boundary$(A) \cap$ boundary$(B)$.

**2.** How to check if two triangular mesh intersect

Two triangular meshes $A$ and $B$ do not intersect iff ...
Approach 1 (good): every edge or vertex of $A$ or $B$ does not intersect any triangle, edge, vertex of $B$ or $A$, respectively (or equivalently, the closure of any edge does not intersect the closure of any triangle).
Approach 2 (bad): every vertex of one triangular mesh is outside of the other. Counter example : Star of David
Approach 3 (good): no pair of closures of triangles intersect each other.

**3.** Calculation of the intersection of an edge and a triangle

Let the triangle ABC and the edge PQ be given. a. check if P and Q lie on opposite side of ABC det(PA, PB, PC) and det(QA, QB, QC) have opposite sign b. check if line of PQ penetrates the ABC det(PA, PB, PQ), det(PB, PC, PQ), det (PC, PA, PQ), and det(PA, PB, PC) have same sign. Note: if one of det(PA, PB, PQ), det(PB, PC, PQ), det (PC, PA, PQ) is 0, then PQ 'contacts' the closure(ABC).

**4.** How to speed up interference detection among many small objects

strategies a. bounding spheres b. oriented bounding boxes c. projections

a. bounding spheres Use a min-max bounding box to find center and radius. The center is (min+max)/2. For the radius, use the length of the vector from the center to the furthest vertex of the polyhedron. This is bad for long, thin objects.

c. projections Theorem: If $\exists$ p, s.t. p(A) $\cap$ p(B) = $\emptyset$, then A $\cap$ B = $\emptyset$. We can use any projection as the function p(). Projecting onto lines: "Triboxes" technique uses 9 axes: x, y, z, x+y, x-y, y+z, y-z, z+x, z-x. Stony Brook technique uses even more lines. Projecting onto planes: Planes have more separating power. Can be approximated using graphics hardware.