# Determine if fibres cross 3D

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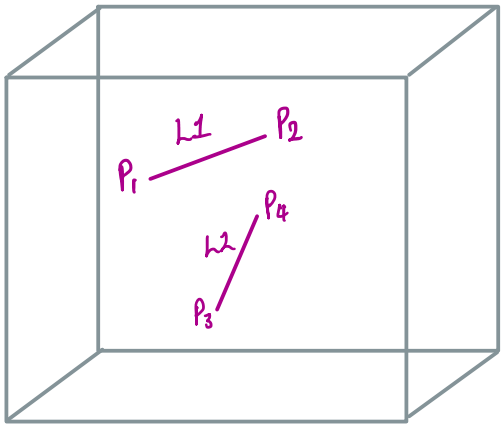
Adapted from https://stackoverflow.com/questions/55220355/how-to-detect-whether-two-segmentin-3d-spaceintersect




Line L1: $P_1 + t_1(P_2 - P_1)$ $t_1 ; t_2 \in [0,1]$

Line L2: $P_3 + t_2(P_4 - P_3)$

at intersection

$$P_1 + t_1(P_2 - P_1) = P_3 + t_2(P_4 - P_3) \quad *$$

Three cases:

① fibres are coplanar and parallel

test: cross product is zero

$$(P_2 - P_1) \times (P_4 - P_3) = 0$$

② fibres are skew (in parallel planes)

test: scalar triple product zero

$$(P_3 - P_1) \cdot [(P_2 - P_1) \times (P_4 - P_3)] \neq 0$$

③ fibres intersect (see below)

from * $t_1 = \frac{P_3 - P_1}{P_2 - P_1} + t_2 \frac{P_4 - P_3}{P_2 - P_1}$

$b = \frac{(P_4 - P_3) \cdot (P_2 - P_1)}{|P_2 - P_1|^2}$

$a = \frac{(P_3 - P_1) \cdot (P_2 - P_1)}{|P_2 - P_1|^2}$

$$\hookrightarrow (a+bt_2)(p_2-p_1) - t_2(p_4-p_3) = p_3-p_1$$

$$\hookrightarrow t_2 \underbrace{\left[b(p_2-p_1)-(p_4-p_3)\right]}_{c} = \underbrace{p_3-p_1-a(p_2-p_1)}_{n}$$

$$\hookrightarrow t_2 = \frac{c \cdot n}{|c|^2}$$

$$t_1 = a + bt_2$$

} check both in $[0,1]$

## Tolerances

if fibres are parallel but within the co-radial distance


if fibres are colinear


if fibres are skew


if fibres meet in a T