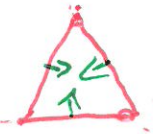
3D Triangle Collision

3 points
- ↳ Three vectors between points → $|p_2 - p_1|$ (1), $|p_3 - p_2|$ (2), $|p_1 - p_3|$ (3)
- ↳ orthogonal → (1) × (2)
- ↳ ABCD
  - ↳ A,B,C = [orthogonal.x, orthogonal.y, orthogonal.z]
  - ↳ D = −(Ax + By + Cz)
  - ↳ D = − orthogonal • (1)



Given Point (4) in inside triangle (1) (2) (3)

find 3 bounding planes
- ↳ ABCD of the three planes
  - ↳ ABC => orthogonal to the bounding plane
  - ↳ D = −(point • orthogonal)

plug point into bounding planes

2 points from the triangle. How do I find the 3rd point on the bounding plane?
$p_3 = p_1 + \text{orthogonal}$

Computational Cost

3 subtractions, 3 ||
1 cross product ×
1 dot product •
3 additions +
3 dot products •
3 dot products •

√ 1. Guess
2. Guess²
3. Compare Guess² to x
   if √x
4. Adjust Guess

√ 1. multiply
1. ~~xxx~~ comparison
1. Addition

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3 + cheap - 3 operations
3 − cheap - 3 operations
Expensive 3 || → 3 divisions, $\sqrt{x^2+y^2+z^2}$ → 3 multiplies, 2 additions, 1 √
1 × · middle — 6 multiplies, 3 additions
7 • middle - 3 multiplies + 2 additions

Practical Ray Tracing advice.
- Trace only 1 triangle at first
- Optimize at the pain points. → Square Roots / length

is x < y length
is x < √abc
is $x^2 < a^2b^2c^2$

Linear Algebra For Computer Graphics

Translation -> Position
Scale
Rotation

1. All matrices in computer graphics are 4x4
2. All points are of length 4 $[x, y, z, w]^T$
3. w is always 1 -> $[x, y, z, 1]^T$

Identity Matrix

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Scale

$$\begin{bmatrix} scaleX & & & \\ & scaleY & & \\ & & scaleZ & \\ & & & 1 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \\ 1 \end{bmatrix} = \begin{bmatrix} a \cdot S_x \\ b \cdot S_y \\ c \cdot S_z \\ 1 \end{bmatrix}$$

Translation

$$\begin{bmatrix} 1 & & & T_x \\ & 1 & & T_y \\ & & 1 & T_z \\ & & & 1 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \\ 1 \end{bmatrix} = \begin{bmatrix} a + T_x \\ b + T_y \\ c + T_z \\ 1 \end{bmatrix}$$

Rotation

Roll → z
Pitch → x
Yaw → y