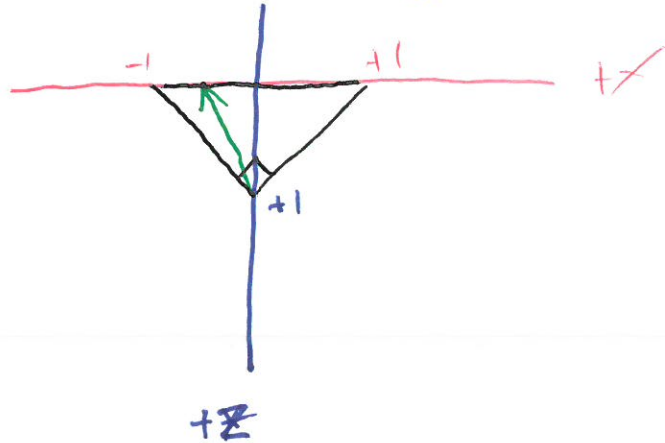


Our First Ray



1. Whenever we have a direction, we want a unit vector!
Always!!!!
A unit vector has a length of 1.
This is called Normalizing

$\text{Pixel}_{xyz} - \text{Origin}_{xyz} = (x, y, z)$ whose length $\neq 1$ i

How to normalize?

1. Get length.

2. Divide By Length

$$\text{Length} = \sqrt{x^2 + y^2 + z^2}$$

$$\frac{x}{\text{Length}}, \frac{y}{\text{Length}}, \frac{z}{\text{Length}}$$

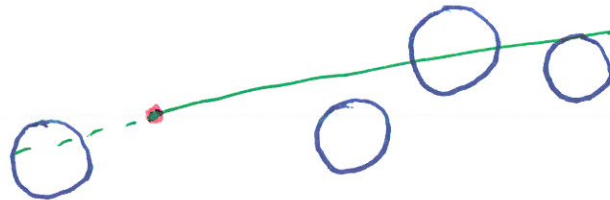
Ray Sphere Intersection

3 kinds of lines

Infinitely long

Ray - origin + direction

Segment - capped



Sphere Definition

$$(x - c_x)^2 + (y - c_y)^2 + (z - c_z)^2 = r^2$$

Ray Definition

$$(O + DT)$$

Ray + Sphere Equation

$$(O + DT - C) \cdot (O + DT - C) - r^2 = 0$$

$$O^2 + ODT - OC + ODT + D^2T^2 - DTC - OC - DTC + C^2 - r^2 = 0$$

$$T^2D^2 + T(2OD - 2DC) + O^2 - 2OC + C^2 - r^2 = 0$$

$$T^2D^2 + T(2D(O - C)) + (O - C)^2 - r^2 = 0 \quad E = (O - C)$$

$$T^2 \overset{A}{D^2} + T(2DE) \overset{B}{+} E^2 - r^2 = 0$$

Both negative X

Negative + positive

Both positive.

Least + positive

$$X = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \rightarrow \text{Discriminant if it's } < 0 \text{ No intersection}$$