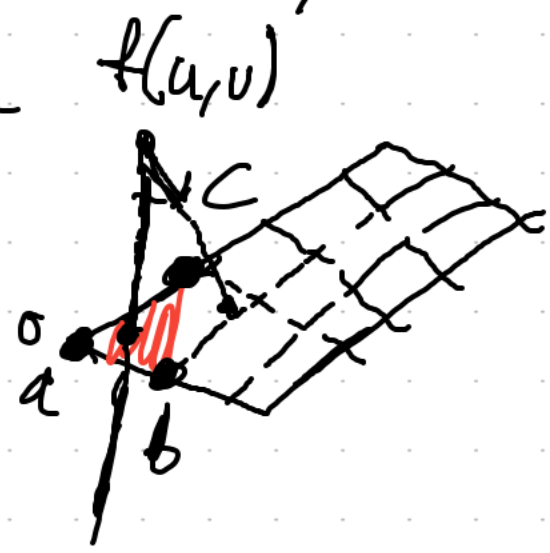
Ray Δ interseection



Consider parametric rep of a plane

And ray $\vec{e}+t\vec{d}$

$e_x+td_x = f_x(u,v)$

$e_y+td_y = f_y(u,v)$

$e_z+td_z = f_z(u,v)$

unknowns: t, u, v

3 eqn & 3 unknowns

we have a Δabc we have a plane defined by 3 points a, b, c

$f(u,v) = \vec{a} + u(\vec{b}-\vec{a}) + v(\vec{c}-\vec{a})$

On the plane and in in Δ

$u \geq 0$

$v \geq 0$ and

$u+v \leq 1$

We have an intersection when

$\vec{e}+t\vec{d} = \vec{a} + u(\vec{b}-\vec{a}) + v(\vec{c}-\vec{a})$

Solve for u, v, t

Expand into 3 equations

① $e_x + t d_x = a_x + u(b_x - a_x) + v(c_x - a_x)$

② $e_y + t d_y = a_y + u(b_y - a_y) + v(c_y - a_y)$

③ $e_z + t d_z = a_z + u(b_z - a_z) + v(c_z - a_z)$

Next rewrite

① $e_x - a_x = u(b_x - a_x) + v(c_x - a_x) - t d_x$

② (sim)

③ (sim)

rewrite as matrix

$$\begin{bmatrix} b_x - a_x & c_x - a_x & -d_x \\ b_y - a_y & c_y - a_y & -d_y \\ b_z - a_z & c_z - a_z & -d_z \end{bmatrix} \begin{bmatrix} u \\ v \\ t \end{bmatrix} = \begin{bmatrix} e_x - a_x \\ e_y - a_y \\ e_z - a_z \end{bmatrix}$$

Solve for (u, v & t)

e.g using Cramers

ray / △ intersection

RAYINTERSECTTRI (ray r, point a, point b, point c)

compute t, u, v

if $(u < 0 \;||\; 1 < v)$ No intersection

if $(u < 0 \;||\; 1 - v < u)$ NoIntersection

if $(t < 0)$ NoIntersection

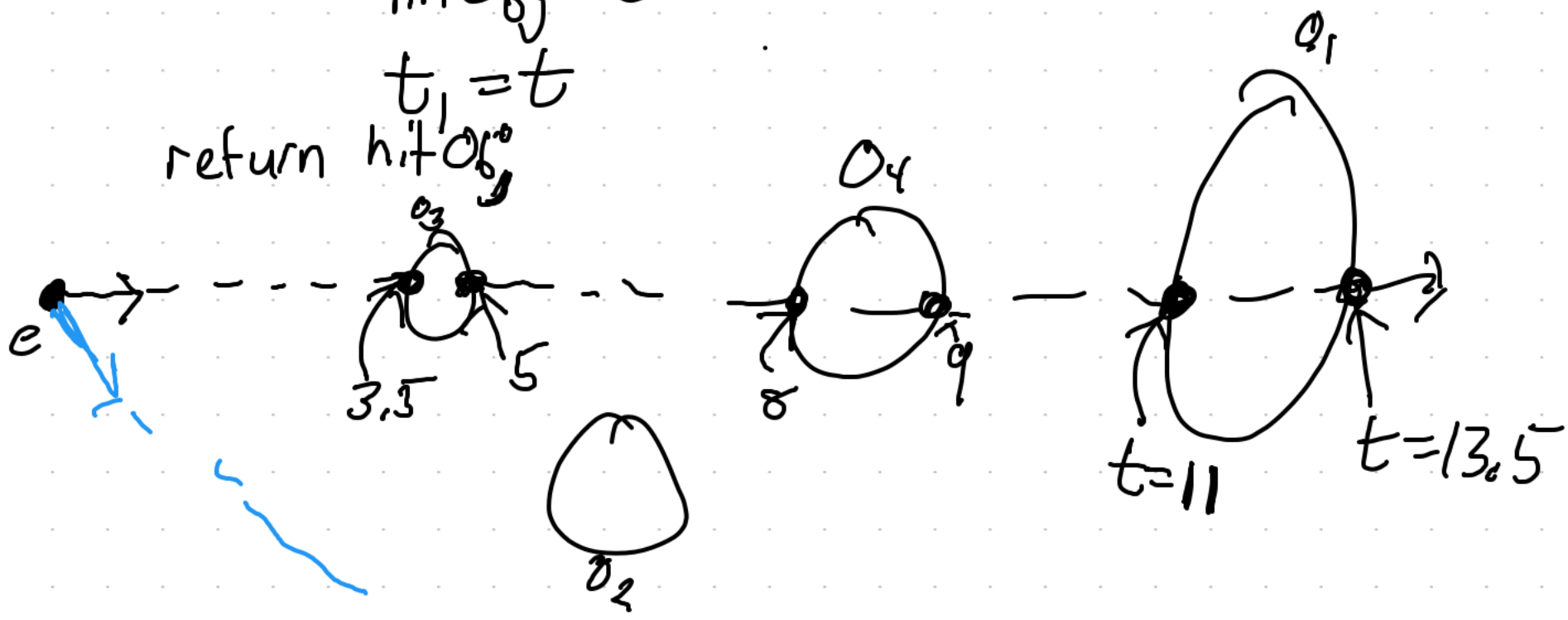
intersection at the point $r.eval(t)$

↳ $\vec{e} + t\vec{d}$

Intersecting a group of objects

FINDINTERSECTION

```
hitObj = ∅
for obj O in ObjectGroup
    if(o is hit by a ray param t
        w/ t ∈ [t0, t1])
        hitObj = o
        t1 = t
return hitObj
```



$t_0 = 0$ O_1 $t_0 = 0$ O_2 $t_0 = 0$
$t_1 = \infty \rightarrow t_1 = 11 \rightarrow t_1 = 11$
$hitObj = \emptyset$ $hitObj = O_1$ $hitObj = O_1$

O_3 $t_0 = 0$ $t_0 = 0$
$\rightarrow t_1 = 3.5 \rightarrow t_1 = 3.5$
$hitObj = O_3$ $hitObj = O_3$

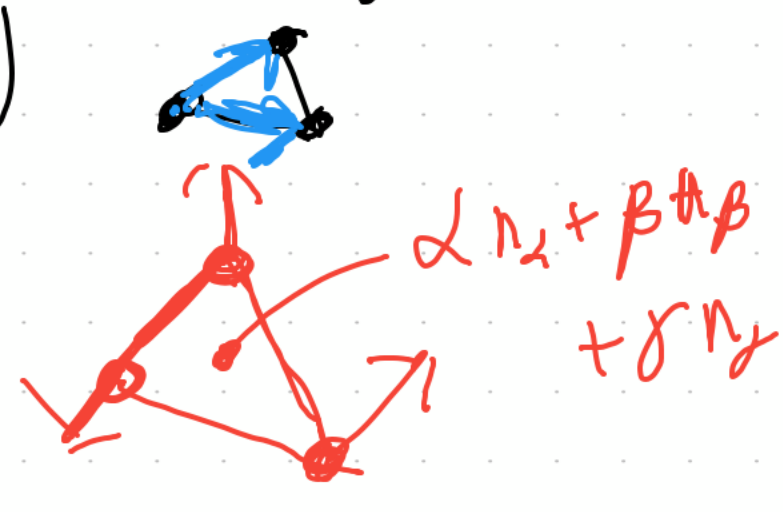
$t_0 = 0$ O_1 $t_0 = 0$ O_2 O_3 O_4 $t_0 = 0$
$t_1 = \infty \rightarrow t_1 = \infty \rightarrow \cdots \rightarrow t_1 =$
$hitObj = \emptyset$ $hitObj = \emptyset$ $hitObj = \emptyset$

Shading

- Use Phong Shading (lab 5 (ish))

What did we need

- intersection point p
- surface normal at p
  - Sphere (implented in lab 5(ish))
  - Δ (lab 6 & exam)



Simple Raytracer

```
for each pixel do
    compute viewing ray
    if (ray hits an object with t ∈ [0, ∞)) then
        Compute n
        Evaluate shading model and set pixel to that color
    else
        set pixel color to background color
```