Ray Tracing

4/5

2 methods:

1) object ordered rendering

```
for obj in Objects
    find all pixels influenced by obj
    color/update pixes influenced by obj
```

ray tracing

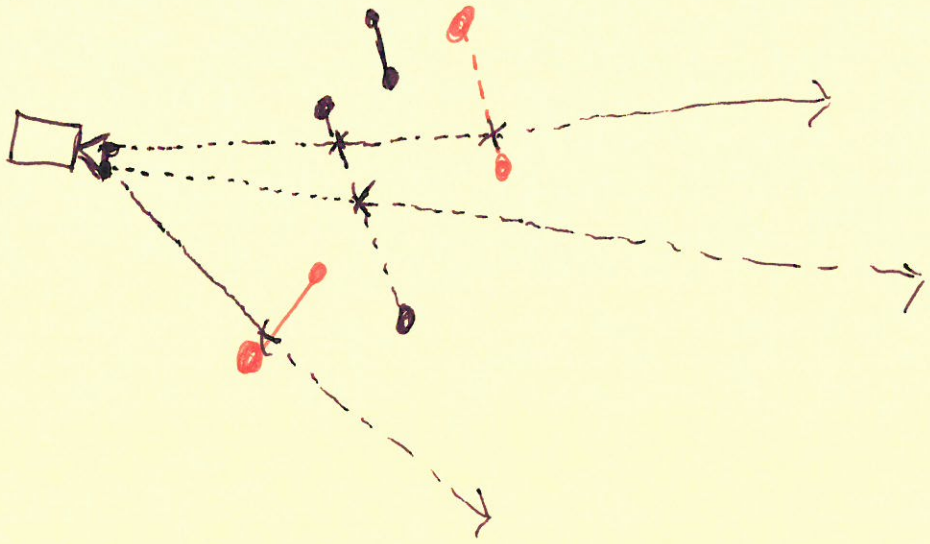
(2) image-ordered

```
for each pixel
    find all objects influencing the pixel
    update pixel
```

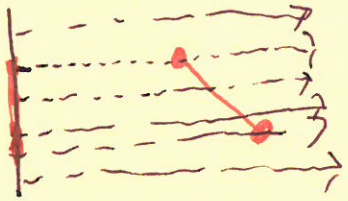
Basic Raytracing algo:

1) ray generation: compute origin & direction for each pixel from camera
2) ray intersection: finds closest object
3) shading: compute color from ray intersection

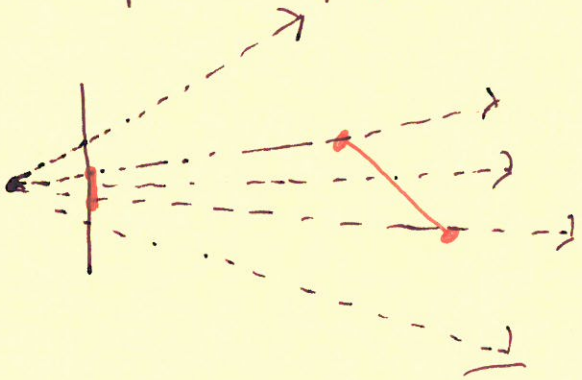
A picture of ray tracing



Recall Orthographic projection



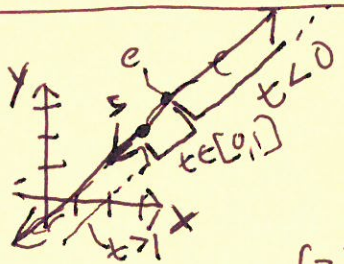
Perspective projection



Computing Rays

Ray rep: $p(t) = e + t(s - e)$

Questons:



$p(t) = \begin{bmatrix} 3 \\ 2 \end{bmatrix} + t \begin{bmatrix} -1 \\ -1 \end{bmatrix}$

draw a ray w/ $e = \begin{bmatrix} 3 \\ 2 \end{bmatrix}$ $s = \begin{bmatrix} 2 \\ 1 \end{bmatrix}$

what points are @ $t \in [0, 1]$

*(a) $t \in [0,1]$ 40Y 0N *(b) $t > 1$ 20Y 5N ~~(c) $t < 0$~~ 0Y 15N

(b) $t > 1$

(c) $t < 0$

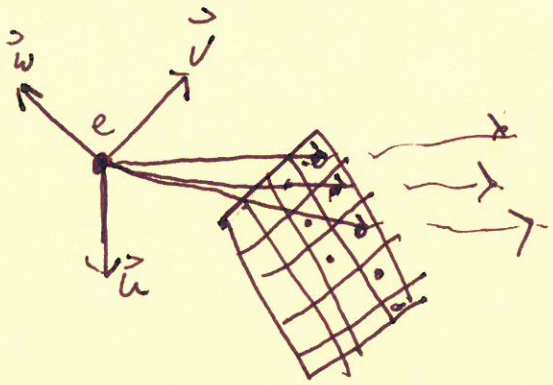
Cameras:

$\vec{e}$: eye

$\vec{g}$: gaze

$\vec{t}$: viewer direction up

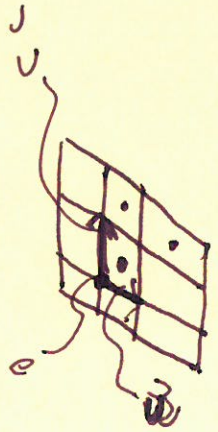
$$\vec{w} = -\frac{\vec{g}}{\|g\|} \qquad \vec{u} = \frac{\vec{t} \times \vec{w}}{\|\vec{t} \times \vec{w}\|} \qquad \vec{v} = \vec{w} \times \vec{u}$$



Orthographic view

all rays have same direction: $-\vec{w}$

what are the origin of each ray



given:

l = left boundary
r = right boundar
t = top boundary
b = bottom boundary

n_x = number of pixels in x

n_y = number of pixels in

$l < 0 < r$
$b < 0 < t$

we fit a $n_x \times n_y$ image into an $(r-l) \times (t-b)$ rect

per pixel

horizontal spacing: $(r-l)/n_x$

vertical spacing: $(t-b)/n_y$

a pixel (i, j) for the image

$$u = l + (r-l)(i + 0.5)/n_x \quad (*)$$
$$v = b + (t-b)(j + 0.5)/n_y$$

orthographic

generate view rays for each pixel (i,j)

compute u, v w/ $(*)$

ray.direction $= -\vec{w}$

ray.origin $= \vec{e} + u\vec{u} + v\vec{v}$

for perspective

generate view rays w/ camera at dist d for each pixel (i,j)

compute u, v w/ $(*)$

ray.direction $= -d\vec{w} + u\vec{u} + v\vec{v}$

ray.origin $= e$