# Thoughts about the Exam

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# Basic ray tracing: obvious questions

- Intersect the ray *** with the sphere ***
  - Does the ray intersect the sphere?
  - How would you test?
- How would you use an oct-tree to speed up a ray tracer?
  - Why would a kd tree be better?
- How would a volume hierarchy speed up a ray tracer?
  - Why is it OK to have one triangle sit in several cells?
- Describe the ray tree
  - How can you prune it?

# Distributed ray tracing: obvious questions

- What causes motion blur?  How do I ray trace it?
- Describe a situation where a ray tracer would alias
  - How does super sampling prevent this?
  - Can a supersampled ray tracer alias?
  - Why do we cast rays through random locations?
  - What are pseudo random points?
- Why do cameras have lenses?
  - What is the thin lens equation?
  - Where does this point focus with this lens?
  - What is depth of field? aperture?
  - What is the depth of field for a pinhole camera?
  - T/F  Larger aperture=larger depth of field
  - What is chromatic abberation?

# Lighting and Shading: obvious questions

- In this geometry, sketch the refracted ray
- What is specular-diffuse transfer?
  - sketch a geometry that a simple ray tracer would render incorrectly
  - how can one render them?
- What are caustics?
  - how are they formed?
- What is diffuse-diffuse transfer?
- Describe final gathering
  - why is this a good rendering strategy?
- What light paths are rendered by a simple ray tracer?
  - why do diffuse bounces complicate rendering?

# What is wrong with this pathtracer? -AI

$$\text{shade}(x) = E(x) + \rho(x)\text{direct}(x) + \text{RKBME}(x)$$

$$\text{direct}(x) = \sum_{l \in \text{luminaires}} \text{directfromL}(x, l)$$

directfromL(x, L)

generate $N$ uniform random samples $u_i$ on luminaire $L$ with area $A_l$
return $\frac{A_l}{N} \sum_i \frac{\cos\theta_x \cos\theta_u}{\pi r^2} E(u_i)$

# What is wrong with this pathtracer? -AII

RKBME(x)

Generate $M$ points $p_i$ uniformly at random on unit hemisphere at $x$
For each point $p_i$, write $u_i$ for the first hit on the ray from $x$ to $p_i$
write $\cos\theta_{si}$ for the cosine at $x$ of the $i$'th direction

return $\rho(x) 2\pi \frac{1}{\pi} \frac{1}{M} \sum_i \left(\rho(u_i)\text{direct}(u_i) + \text{RKBME}(u_i)\right) \cos\theta_{si}$

# Does this pathtracer get the right answer?

RKBME(x, depth)

Generate $M$ points $p_i$ uniformly at random on unit hemisphere at $x$
For each point $p_i$, write $u_i$ for the first hit on the ray from $x$ to $p_i$
write $\cos\theta_{si}$ for the cosine at $x$ of the $i$'th direction
if depth==0
return 0
else
return $\rho(x)2\pi\frac{1}{\pi}\frac{1}{M}\sum_i\left(\rho(u_i)\text{direct}(u_i) + \text{RKBME}(u_i, depth-1)\right)\cos\theta_{si}$

# Does this pathtracer get the right answer?

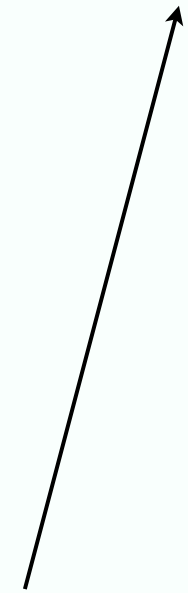
RKBME(x)

Generate $v$ uniform random variable, $v \in [0, 1]$

if $v > \rho(x)$
return 0
else

Generate $M$ points $p_i$ uniformly at random on unit hemisphere at $x$
For each point $p_i$, write $u_i$ for the first hit on the ray from $x$ to $p_i$
write $\cos\theta_{si}$ for the cosine at $x$ of the $i$'th direction

return $2\pi \frac{1}{\pi} \frac{1}{M} \sum_i \left(\rho(u_i)\text{direct}(u_i) + \text{RKBME}(u_i)\right) \cos\theta_{si}$



And what is all this about?

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And what is all this about?

# Area sources and diffuse interreflections

- Why do area sources produce soft shadows with slow gradients (drawing)
- You have a small item to grill, and a large bed of coals
  - does it matter how far it is from the grill?
- Explain how to estimate diffuse interreflections
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# Mosaics

- I want to make a flat mosaic out of perspective images, (where camera has rotated about fp, but not translated)
  - why don't image translations work?
  - what is a homography?
  - (roughly) how would I estimate it?
  - How do I make a cylindrical mosaic out of images?
  - what happens to the mosaic if the focal point translates?
  - how do I make images out of a cylindrical mosaic?
  - how can I remove things from a mosaic?

# Epipoles, etc.

- Here are two cameras
  - draw: epipoles, two epipolar lines, p1 in *right* camera
- Match drawings of epipolar structures to camera movements in list
  - translate parallel to image plane
  - rotate about focal point
  - translate along vector perp to image plane through fp
  - translate, then swing inwards
- What is disparity?
  - how can we use it in image-based rendering?
- Here is a stereo pair
  - are there points in the left (resp. right) image that can't be seen in right (resp. left) image?
  - why?
  - what is the significance of this effect?

# Light fields and stuff

- What is a light field?
  - how would you make a light field for a real object?
    - a synthetic object?
  - how would you render it?

# Texture synthesis

- I have a 16x9 aspect ratio image I want to turn into 4x3 ar
  - how can I do this with seam carving?
- I have a 4x3 aspect ratio image I want to turn into 16x9
  - how can I do this? (two methods)
  - which method is better?
  - why?
  - how can I use seam carving to do this?

# Animation

- Sketch a hermite curve for this control structure
  - why do we care about hermite curves?
  - why is interpolation useful?
- I have a structure with forward kinematics x(theta)
  - I want to move the endpoint by dx - what dtheta do I use?
  - what is kinematic redundancy? where does it occur?
  - what is a kinematic singularity? give an example
- I simulate a firework with a particle moving in a potential field
  - if the only potential is gravity, what is its form?
  - the state of the particle is its position and velocity; how do I get state at time t+1 from state at time t?
  - write the potential as phi(x); show the particle conserves energy

# Animation

- Why are particle systems well-liked?
  - I want to simulate cloth with a spring-mass system; what could go wrong?
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