

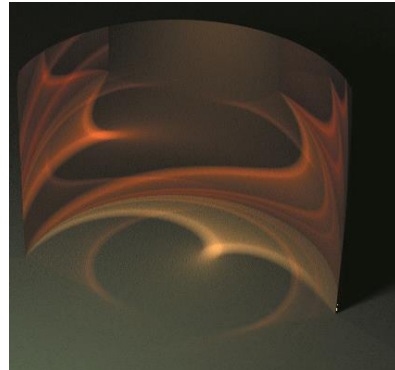
Global Illumination

1. Regular Expressions for Light Transport

We can describe light transport paths using regular expressions.

L=light	E=eye
D=diffuse surface	S=specular surface
G=glossy surface	
* = 0 or more times + = 1 or more times	

Write down expressions for the light paths you can see in these images.



2. Russian Roulette

The code below is based on *smallpt: Global Illumination in 99 lines of C++*. Complete it so that it correctly employs RR is the recursion depth is greater than 5. Why do we only start using RR at deeper levels?

```
// p = maximum reflectance of surface, fr = BRDF value, depth = recursion depth
double U=drand48();
if ( _____ )

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        fr = _____
        return obj.emission + compute_illumination(fr,...and other stuff);
    else
        return obj.emission;
```

3. Irradiance Caching

$$E(\mathbf{x}, \mathbf{n}) \approx \frac{\sum_{i \in S} w_i(\mathbf{x}, \mathbf{n}) E_i}{\sum_{i \in S} w_i(\mathbf{x}, \mathbf{n})}, \quad w_i(\mathbf{p}) = \frac{1}{\frac{\|\mathbf{p} - \mathbf{p}_i\|}{R_i} + \sqrt{1 - \mathbf{n} \cdot \mathbf{n}_i}} - \frac{1}{a},$$

\mathbf{p} is the interpolation point,

\mathbf{n} is the surface normal at \mathbf{p} ,

\mathbf{p}_i is the position of the i -th cached record (stored in the cache),

\mathbf{n}_i is the surface normal at \mathbf{p}_i (stored in the cache),

R_i is the distance to the surfaces visible from \mathbf{p}_i (computed as the harmonic mean or, alternatively, the minimum of the ray lengths in hemisphere sampling and stored in the cache),

a is a user-defined constant specifying the allowed approximation error, discussed in more detail below.

From *Practical Global Illumination with Irradiance Caching* by Krivanek and Gauthron

For a given hit point \mathbf{x} with normal \mathbf{n} , an estimate of the irradiance produced by indirect illumination at \mathbf{x} can be constructed based on a weighted average of the irradiance at previous hit points.

- Acquire a worksheet partner and develop descriptions for the purpose of the two summands in the denominator of w_i .
- The weights use $R_i = M / \sum 1/r_i$ where M is the number of rays sampled around the hemisphere and r_i is the distance a ray travels before hitting a surface. What would be a potential alternative to hemisphere sampling around \mathbf{p}_i to construct a similar measure?
- The image below computed the radiance at each pixel in scanline order using irradiance caching. Suggest one possible source of the artifacts seen in the image. Suggest an alternative rendering strategy to resolve this issue.

