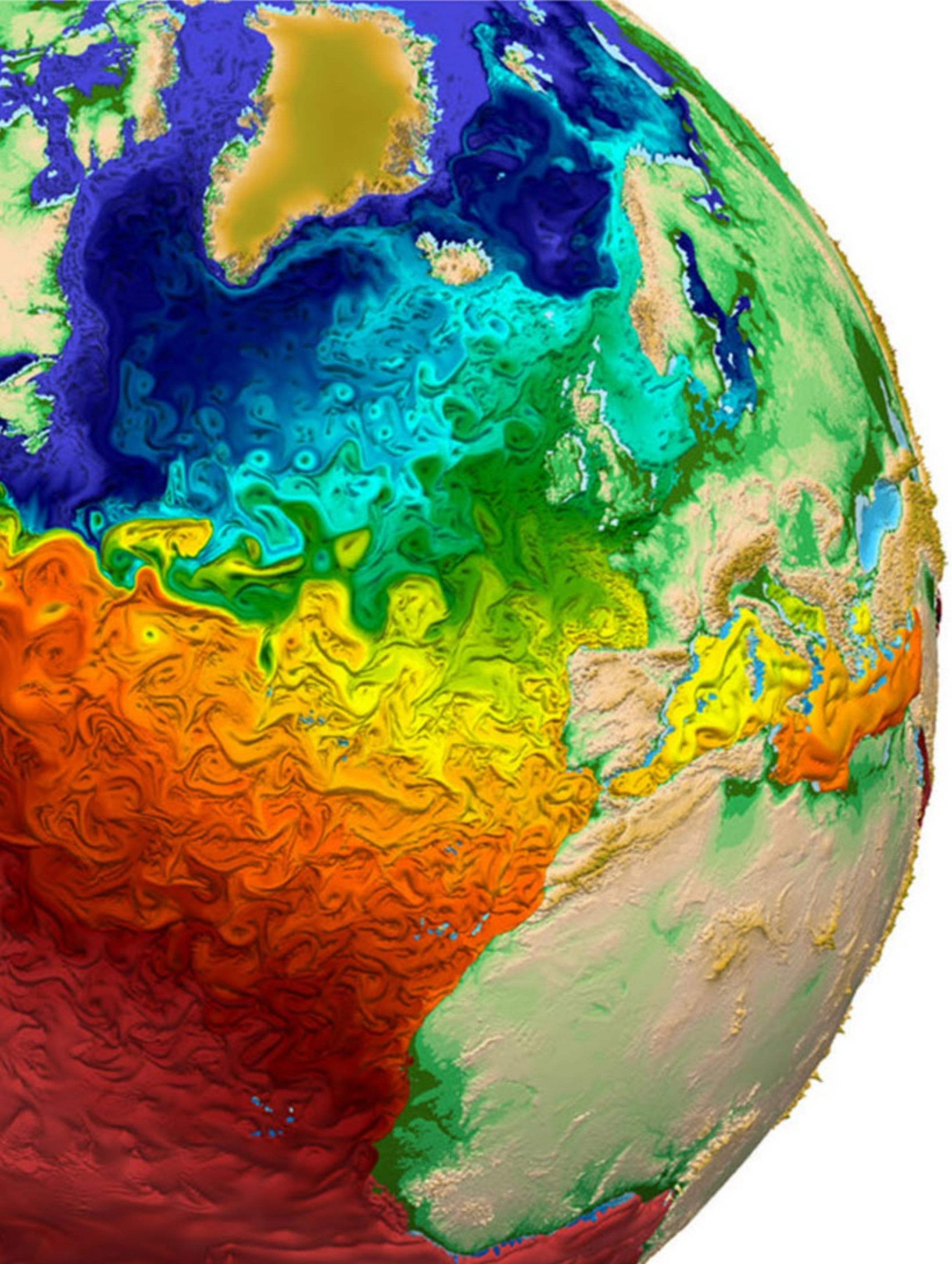


Volume Rendering

Volumetric Shading

Scientific Visualization

Professor Eric Shaffer

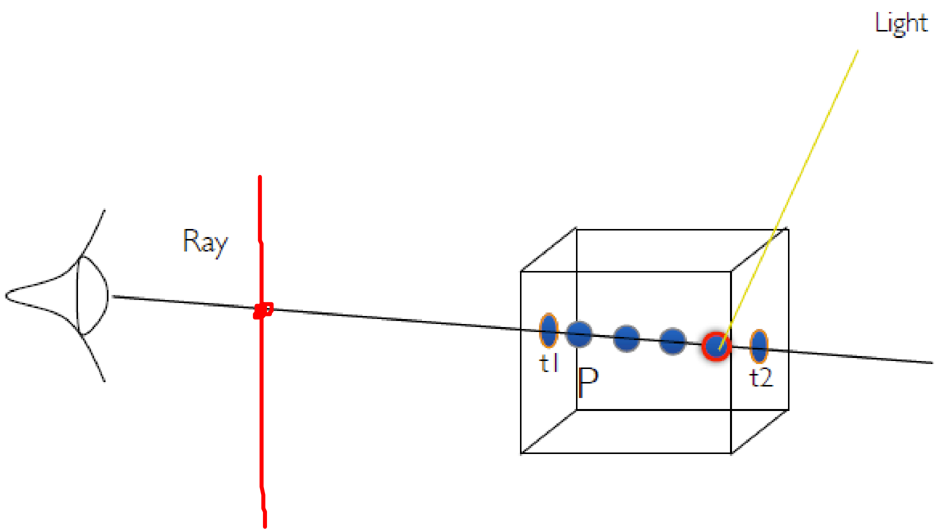
ILLINOIS

Basic Idea

Shading allows viewers to perceive 3D shape and structure

Can apply shading to the volumetric data

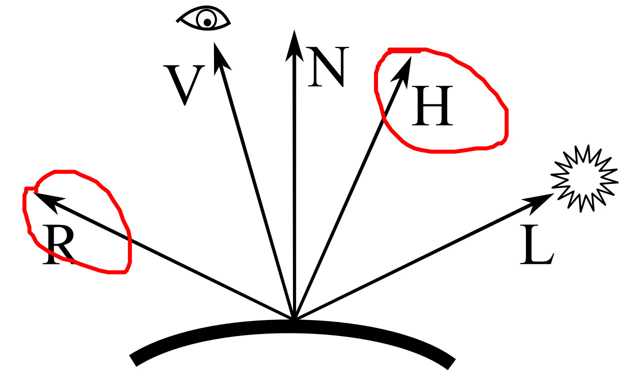
Use it to modify light emitted at a sample point

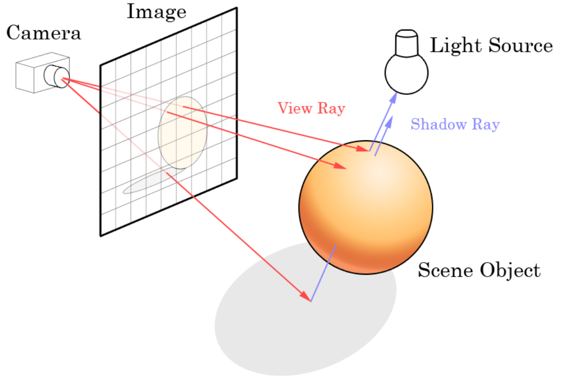


ILLINOIS

The Blinn-Phong Reflection Model

$$I_\mathrm{p} = k_\mathrm{a} i_\mathrm{a} + \sum_{m\,\in\,\mathrm{lights}} \left(k_\mathrm{d}(\hat{L}_m \cdot \hat{N}) i_{m,\mathrm{d}} + k_\mathrm{s}(\overset{H}{\cancel{\hat{R}_m}} \cdot \hat{V})^\alpha i_{m,\mathrm{s}}\right)$$





The material values are generated by the transfer function

- k_a and $k_{m,s}$ and $k_{m,d}$
- Customary to use (1,1,1) for i_a and $i_{m,s}$ and $i_{m,d}$

L is easy to compute given L_{pos} the light position: $L = \frac{L_{pos}-P}{\|L_{pos}-P\|}$

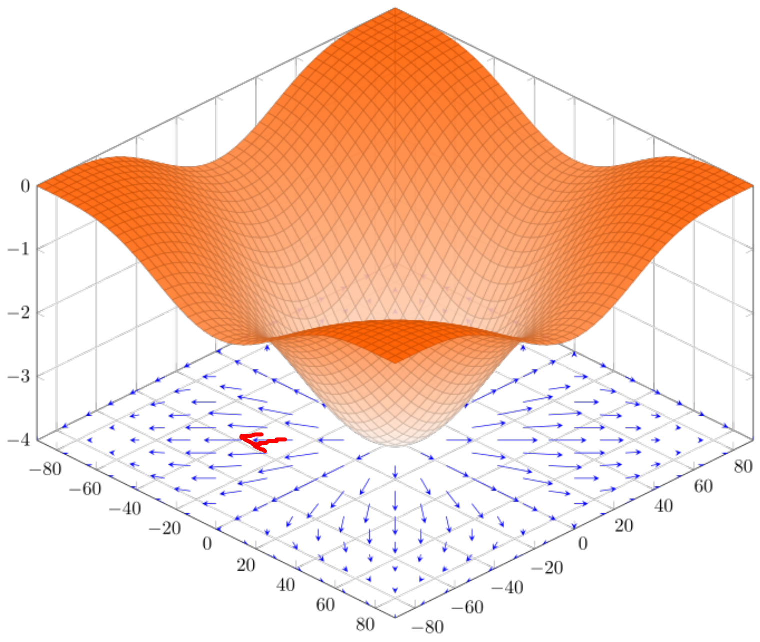
V can be computed using eyepoint E behind view plane: $V = \frac{E-P}{\|E-P\|}$

Can substitute H for R in the equation…with $H = \frac{V+L}{2}$

Need to compute the normal N…..

The Gradient

$$\nabla f(p) = \left\langle \frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}, \frac{\partial f}{\partial z} \right\rangle$$



Points in the direction of most rapid ascent in function values

Gradient of a function is normal to a contour of a function

Can use gradient as a normal…imagine point on the ray has been sampled from an isosurface

Approximating the Gradient

If the gradient cannot be determined analytically, can approximate it numerically

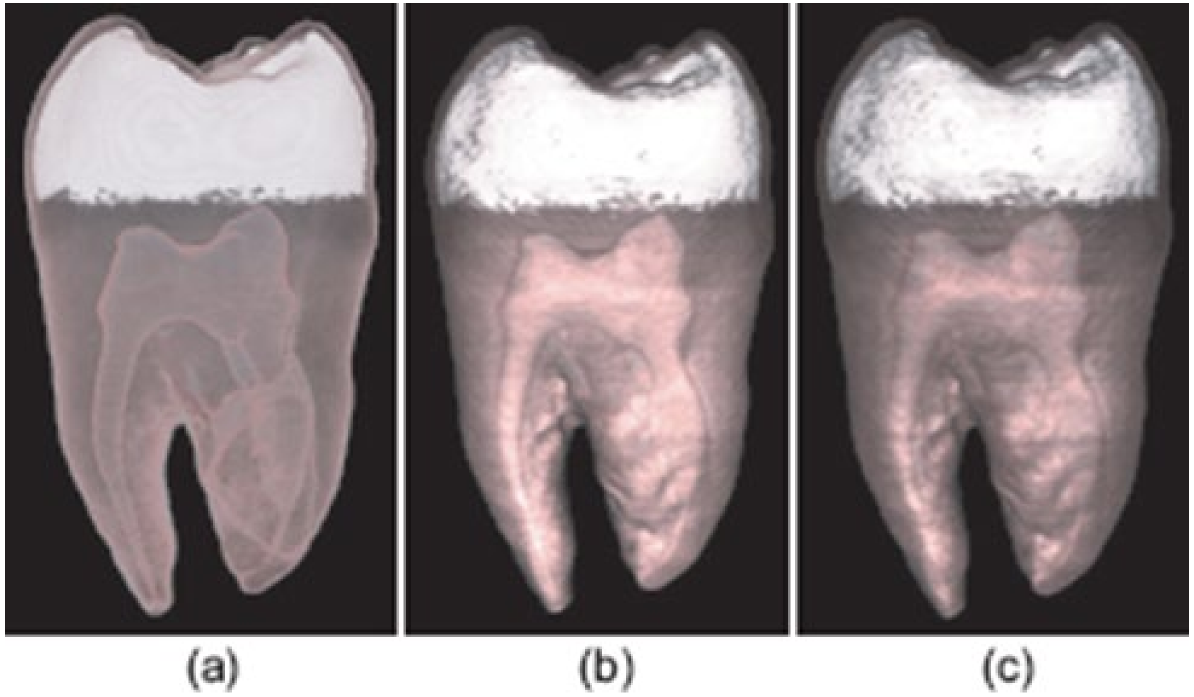
e.g when function f is unknown

central difference formula

$$\nabla f(p) \approx \left\langle \frac{f(x+h,y,z) - f(x-h,y,z)}{2h}, \frac{f(x,y+h,z) - f(x,y-h,z)}{2h}, \frac{f(x,y,z+h) - f(x,y,z-h)}{2h} \right\rangle$$

Use trilinear interpolation to sample scalar field values

Volumetric Shading



No Shading Diffuse Specular