Decoupling Illumination From Isosurface Generation

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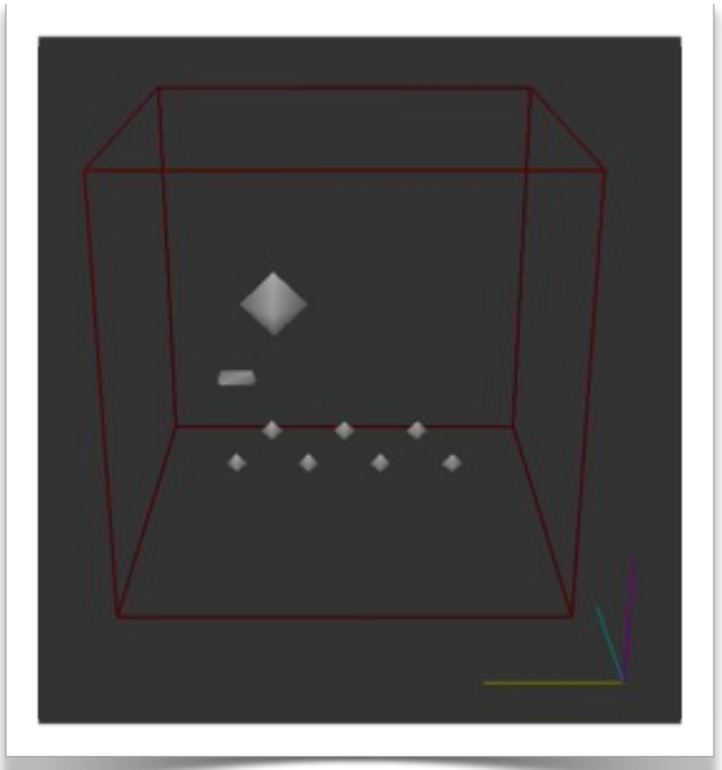
Problem

Interactively view volumetric dataset as an isosurface with global illumination

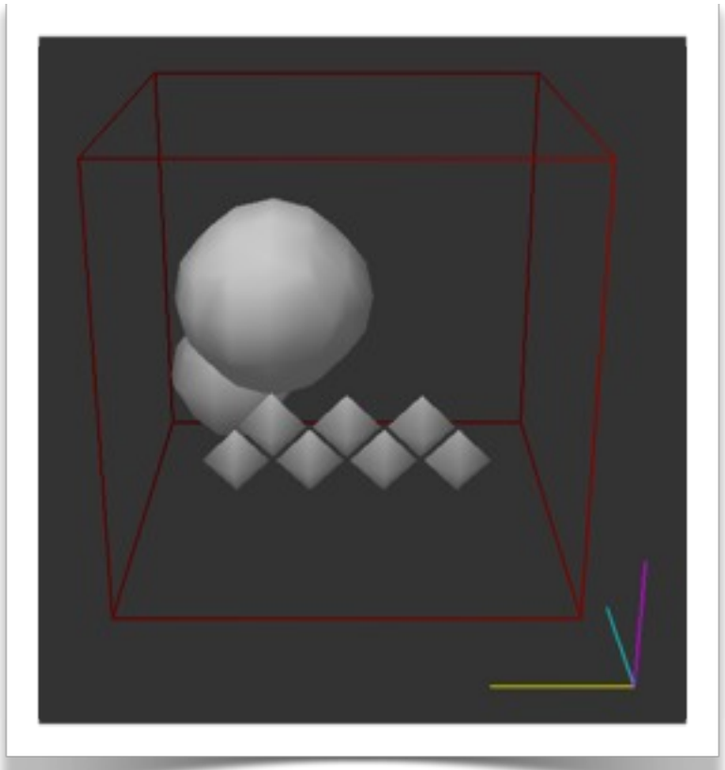
Solved by precomputing lighting

Aim to replicate the results of Beason and Banks who improved upon current methods

Isosurfaces



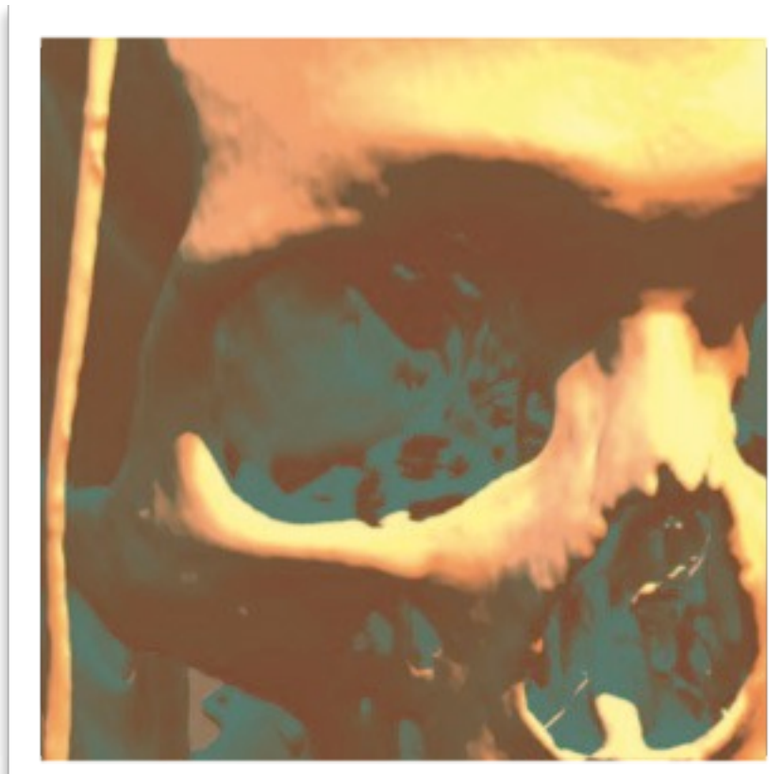
p = 0.75



p = 0.25

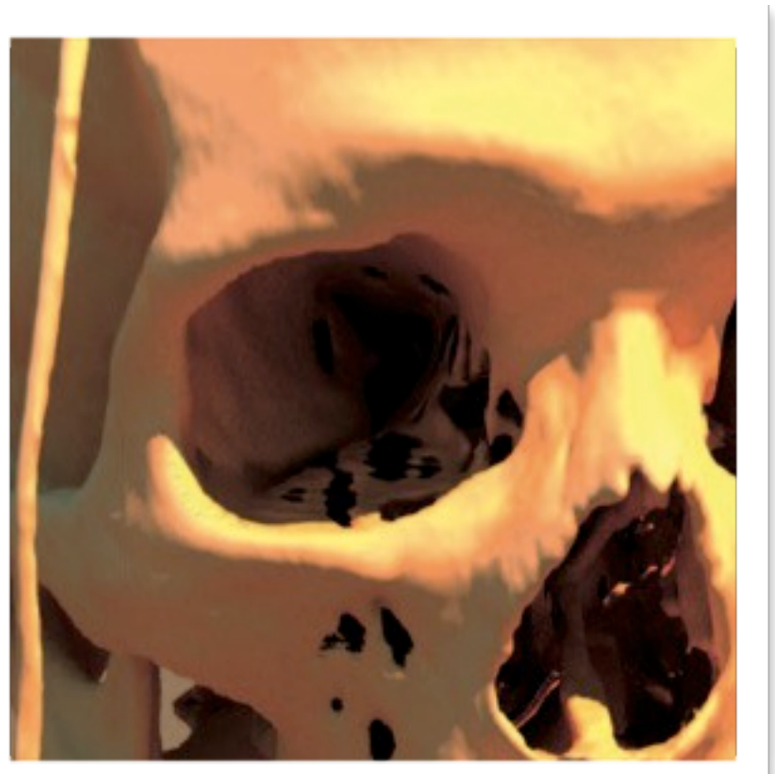
Surfaces defined by a single parameter
(the *isovalue p*)

Illumination Models



Local

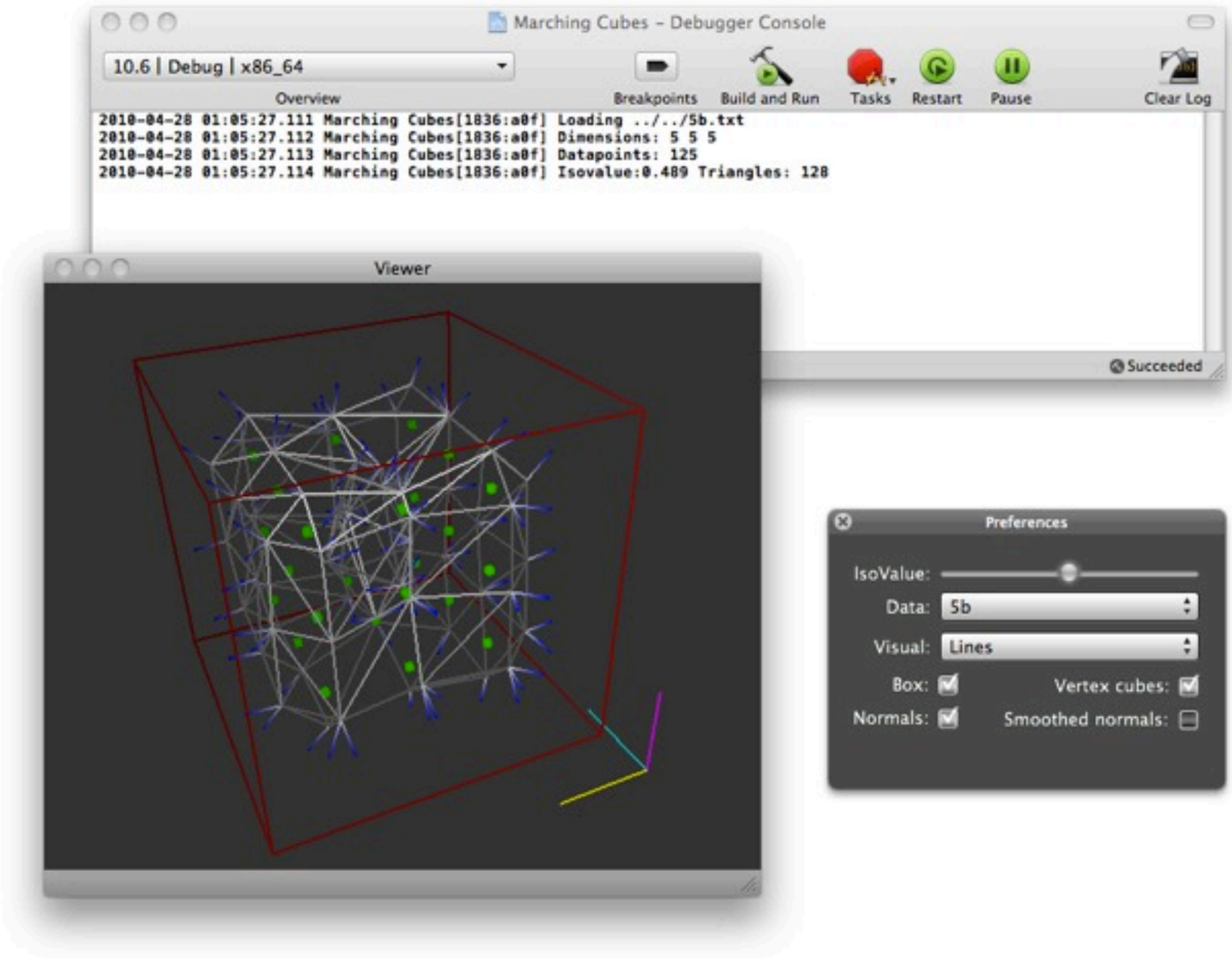
Phong with shadows



Global

Precomputed, ray traced

Interface



Cocoa + Objective-C, Debugging oriented

Precomputed lighting

❶ Sample radiance values

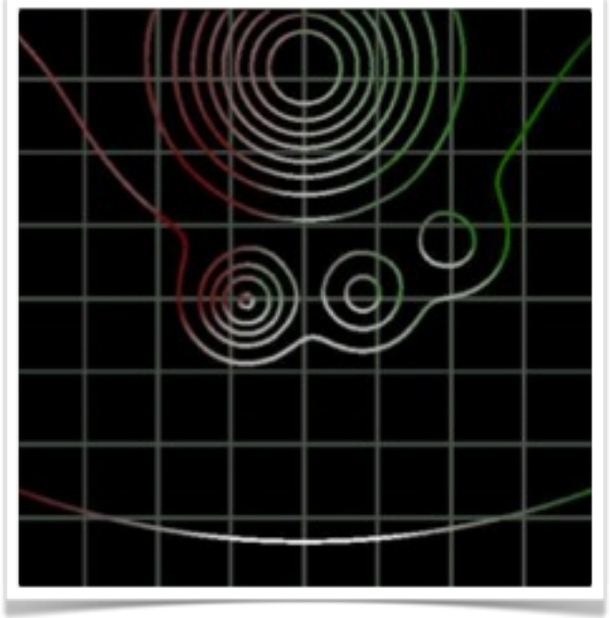
❷ Interpolate to 3D texture

❸ Extract isosurface

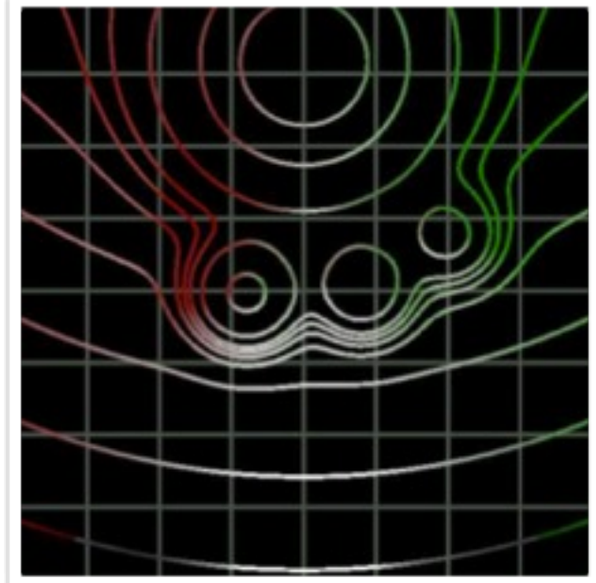
❹ Texture-map radiance onto isosurface

❶ Sampling

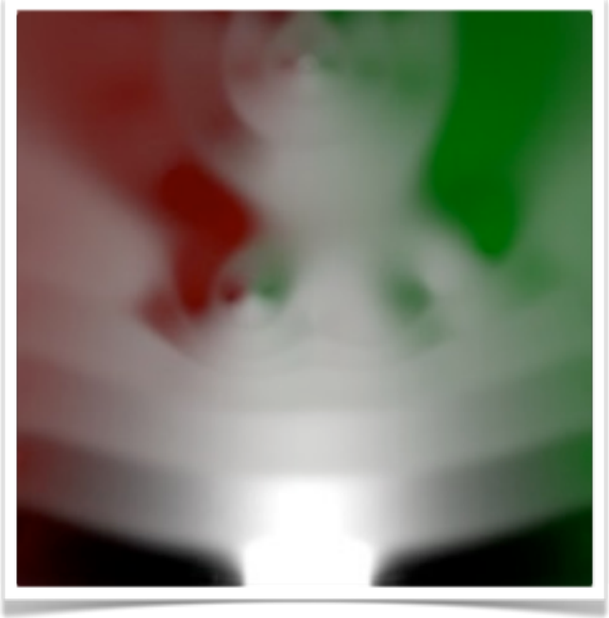
Non-Uniform



Undersampled Regions



Oversampled regions

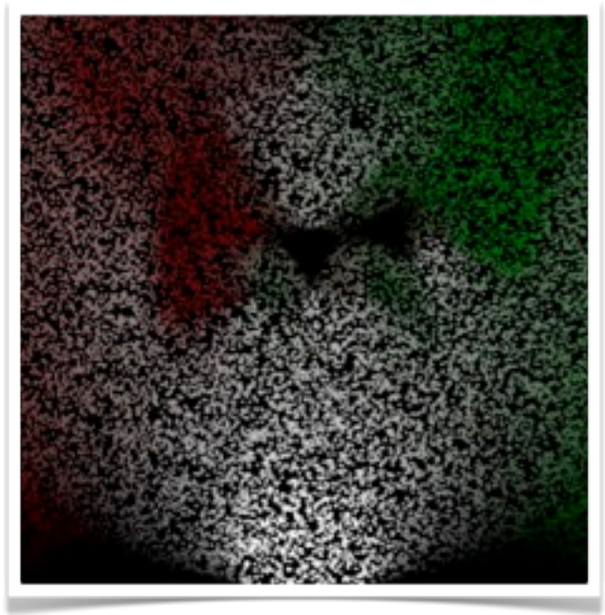


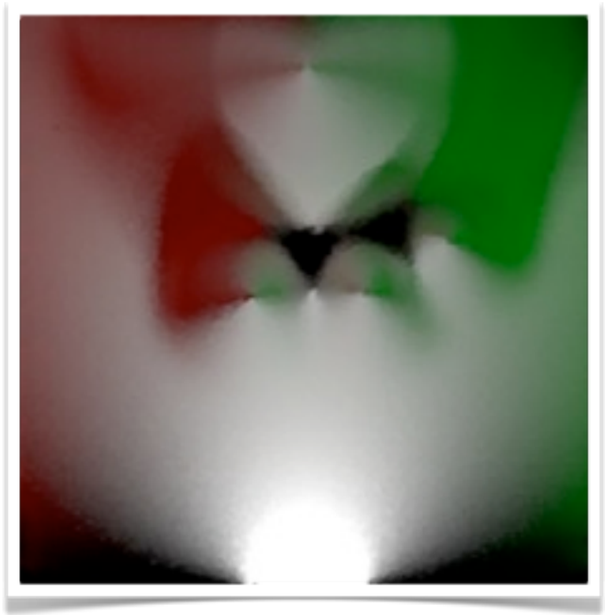
Result

Infinite isosurfaces = infinite computation time

❶ Sampling

Uniform (random)



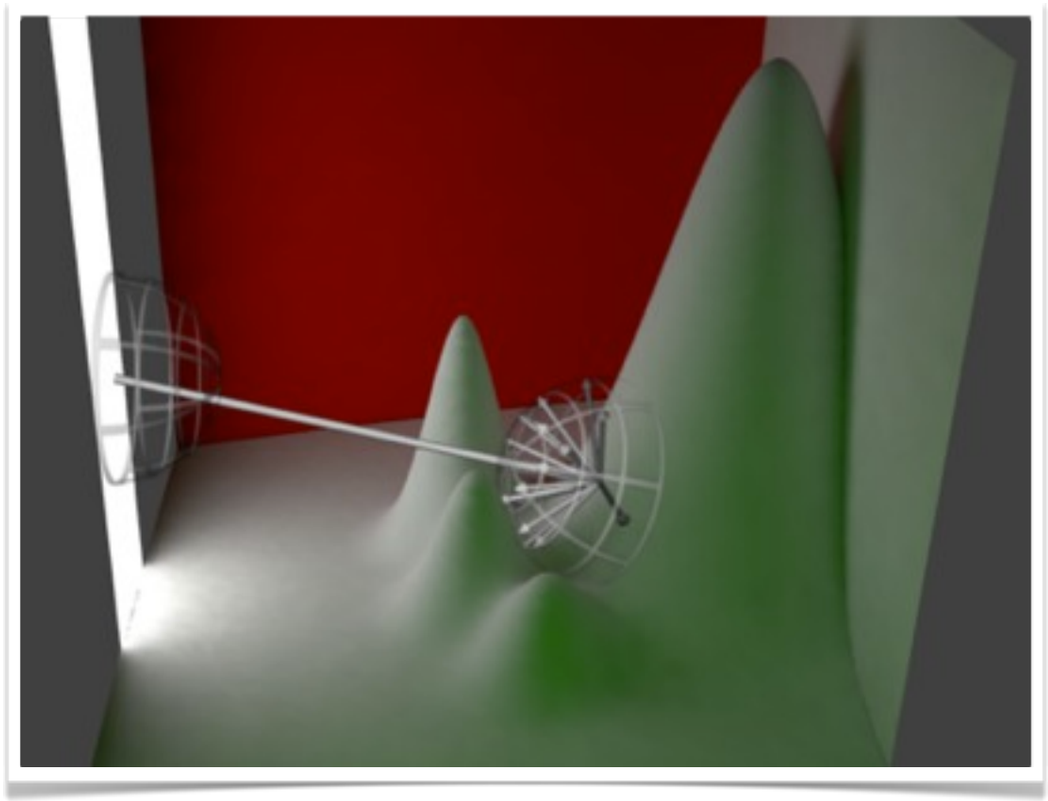


Random sampling is more efficient

Fewer artifacts

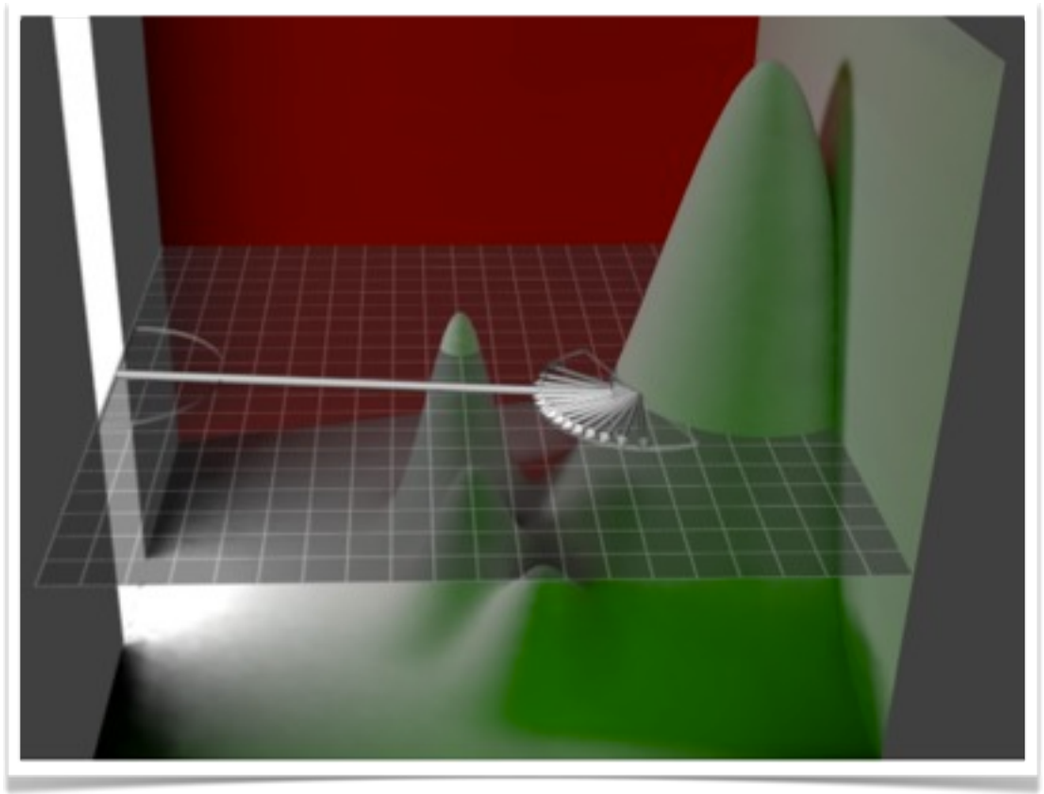
Solution: Light in 4D

- Simultaneously light all 3D surfaces
- Analogous to lighting 3D graph of 2D scalar function

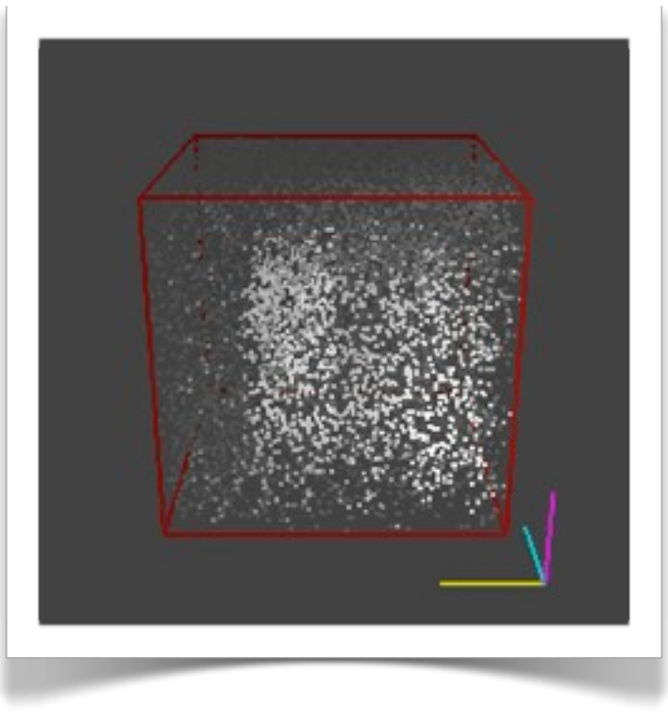


Flattened Light Transport

- Solves problems of light interacting with different surfaces
- Allows us to use the regular 3D light transport equation and reflectance models

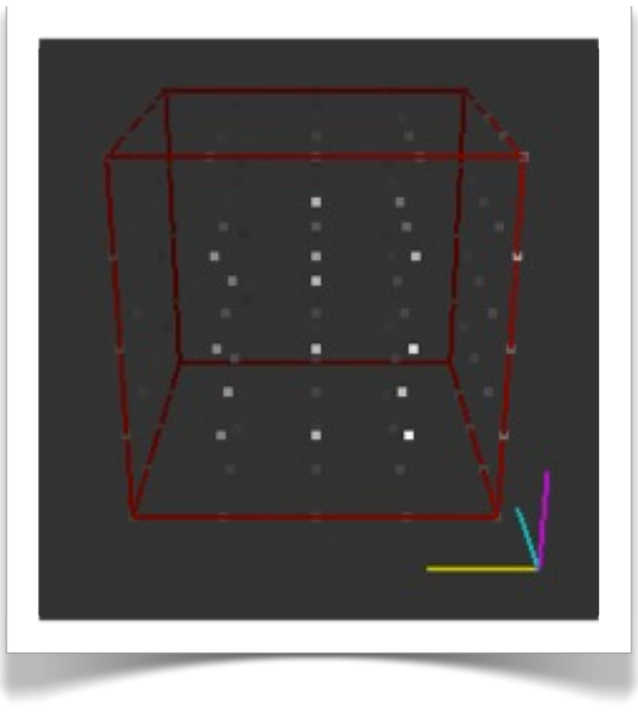


❷ Interpolation



Scattered

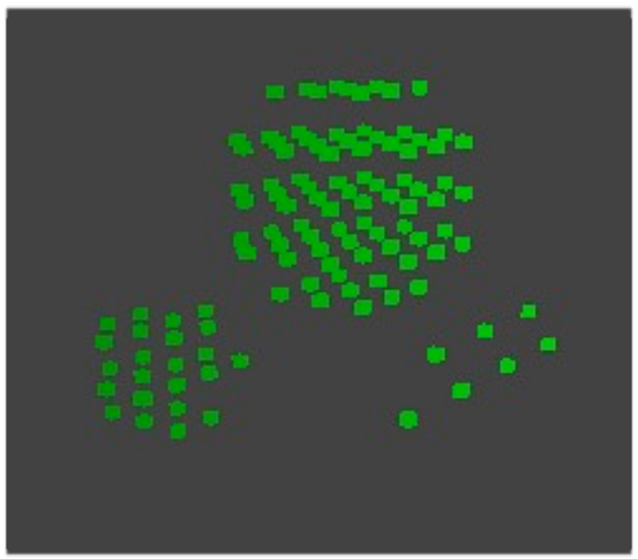
→



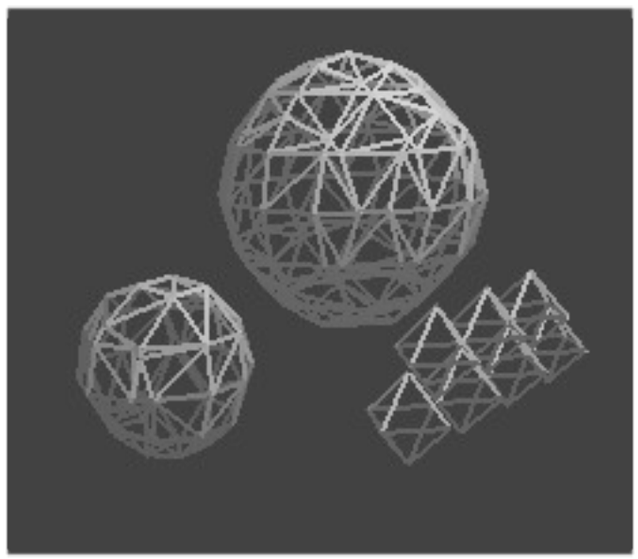
Regular

Inverse distance weighting (Shepard's method)

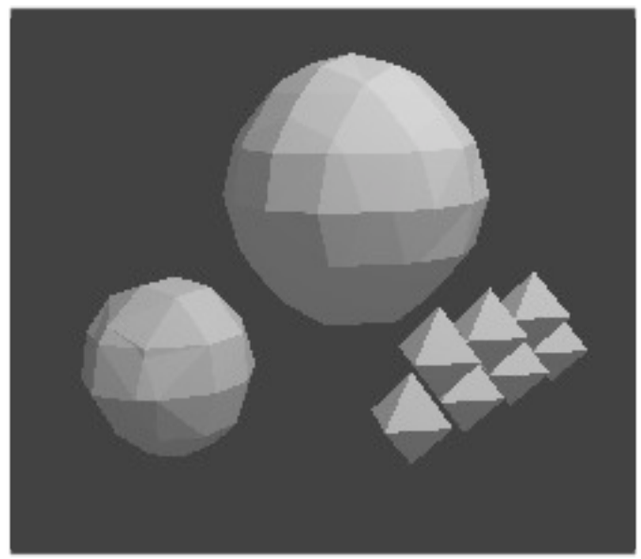
❸ Isosurface Extraction



Active vertices



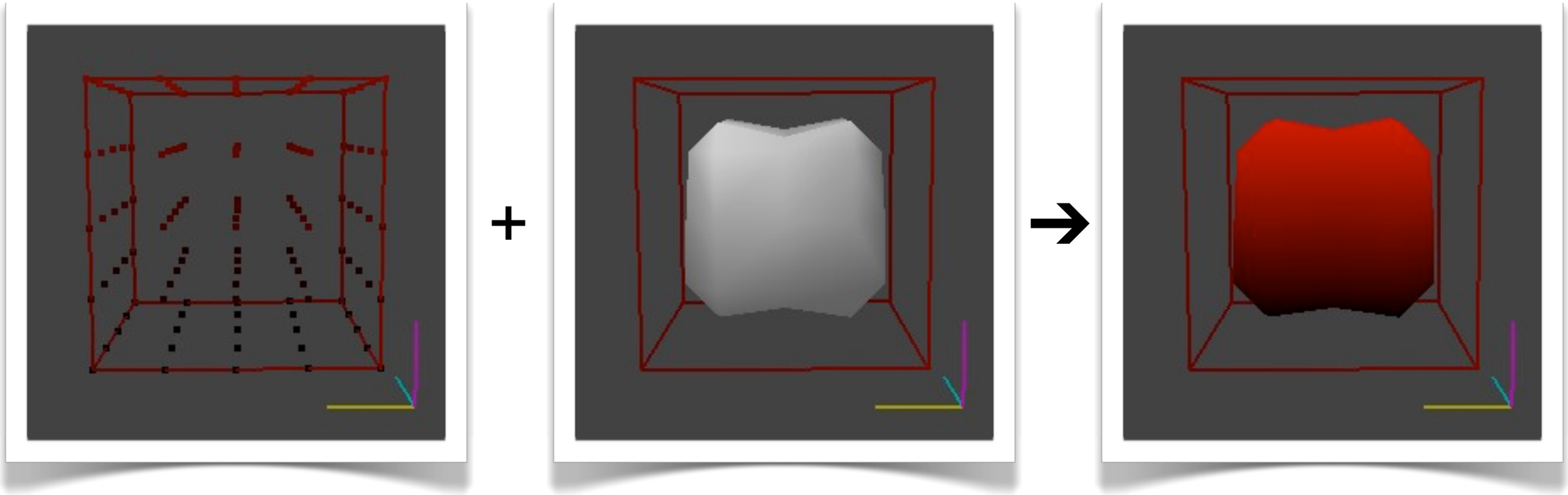
Triangles



Solid surface

Can be done in real-time for small datasets

❹ Texture-mapping



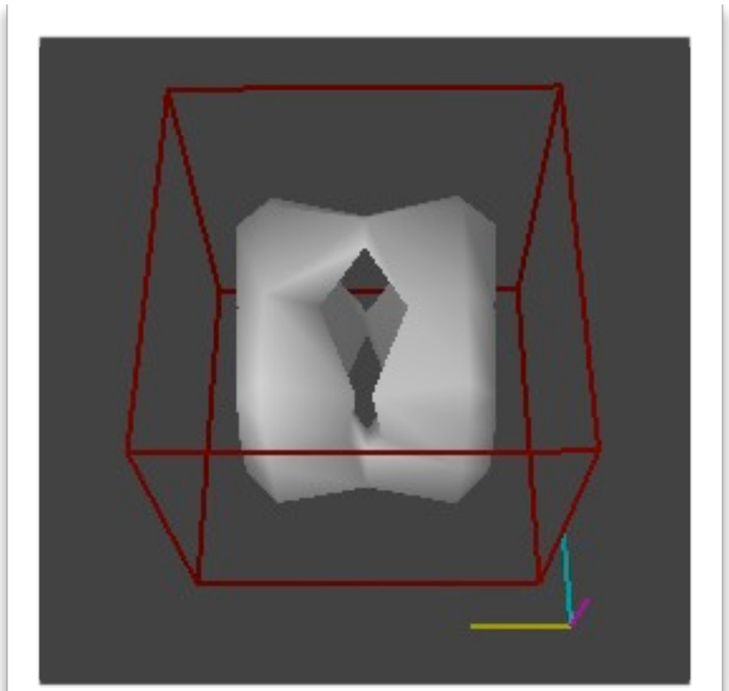
Texture *Isosurface* *Final*

OpenGL with `GL_CLAMP_TO_EDGE`

Texture Mapped Illumination

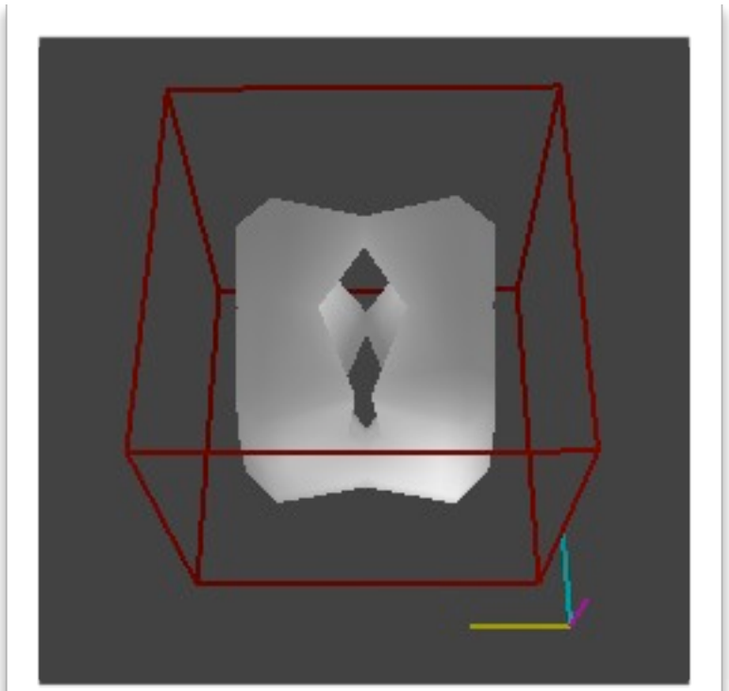
- Any lighting we can store in the texture can be applied efficiently at runtime
  - No specular lighting (rotationally variant)
  - Can provide decent lighting for any 3rd party software that supports 3D textures

Results



Local

Gourad Shading



Global

Precomputed, ray traced

Limited to small datasets because of performance

Questions?

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Pictures from:

Banks, Beason "Decoupling Illumination from Isosurface Generation Using 4D Light Transport"

Wyman, Parker, Shirley, Hansen "Interactive Display of Isosurfaces with Global Illumination"