

Sampling & Reconstruction II

cs348b
Matt Pharr

Overview

- Pixel reconstruction from samples
- Higher-dimensional sampling
- Adaptive sampling
- Anti-aliasing texture
- Current topics in rendering

Pixel Reconstruction

- Theory: perfect reconstruction from uniform samples at Nyquist sampling rate

$$I(x, y) = \sum_i \text{sinc}(x_i - x) \text{sinc}(y_i - y) L(x_i, y_i)$$

- Problems:
 - Non-uniform sample placement to combat aliasing
 - Gibb's phenomenon

Pixel Reconstruction

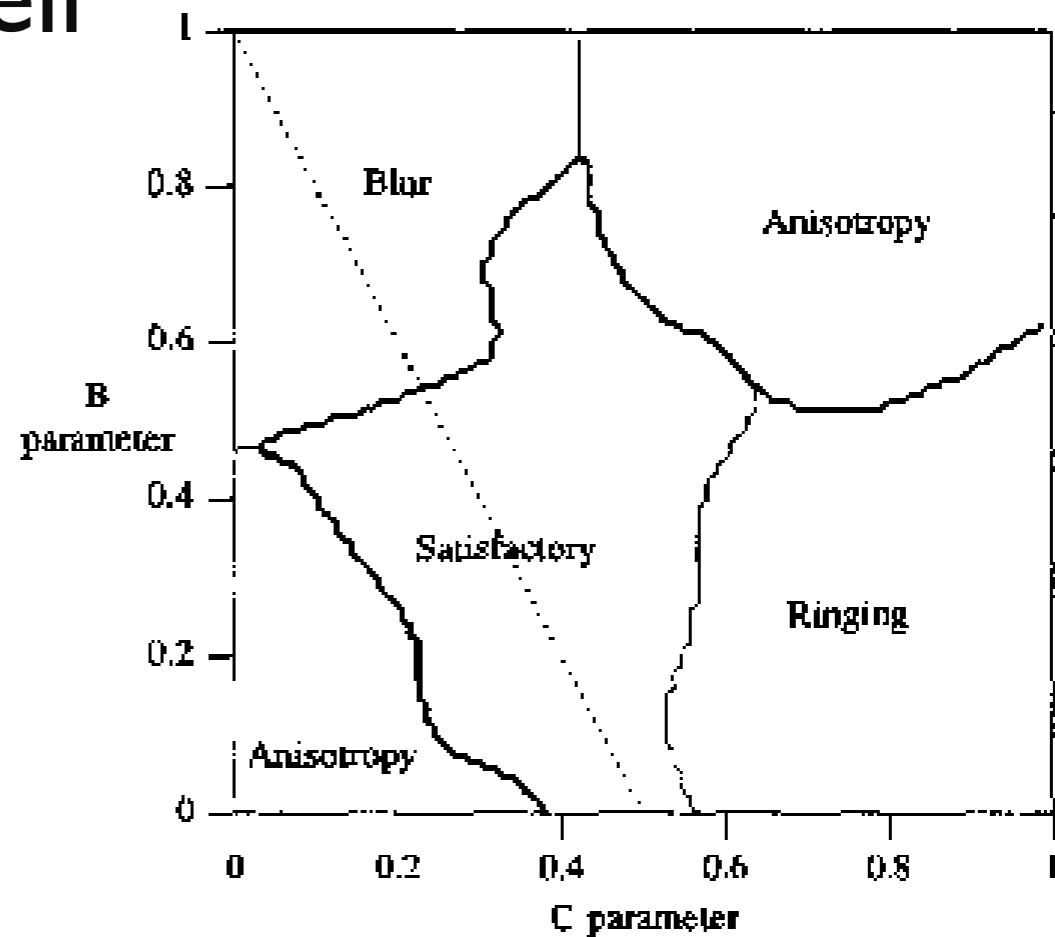
- Practice: weighted average

$$I(x, y) = \frac{\sum_i f(x - x_i, y - y_i) L(x_i, y_i)}{\sum_i f(x - x_i, y - y_i)}$$

- What filter function to use?
 - No solid theory
 - Blurriness vs ringing
 - Negative lobe increases sharpness

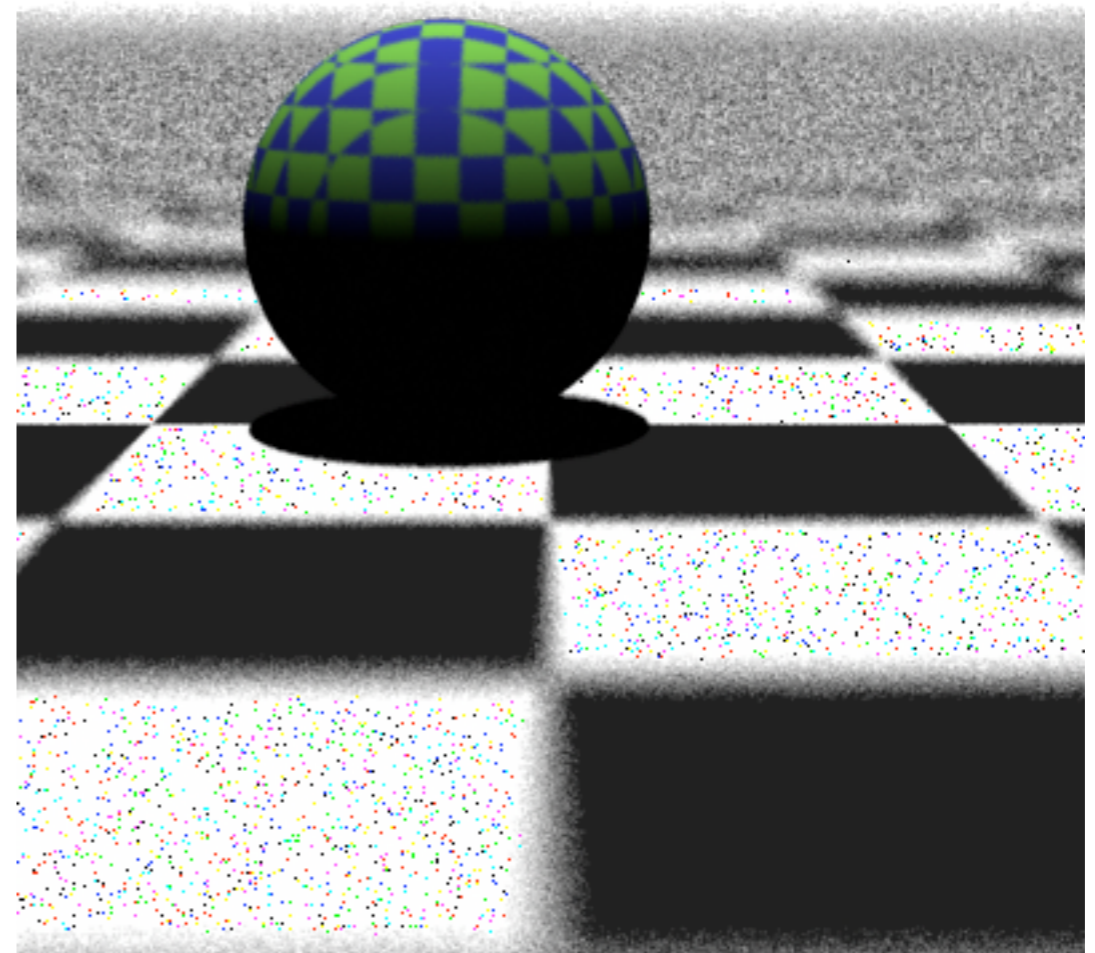
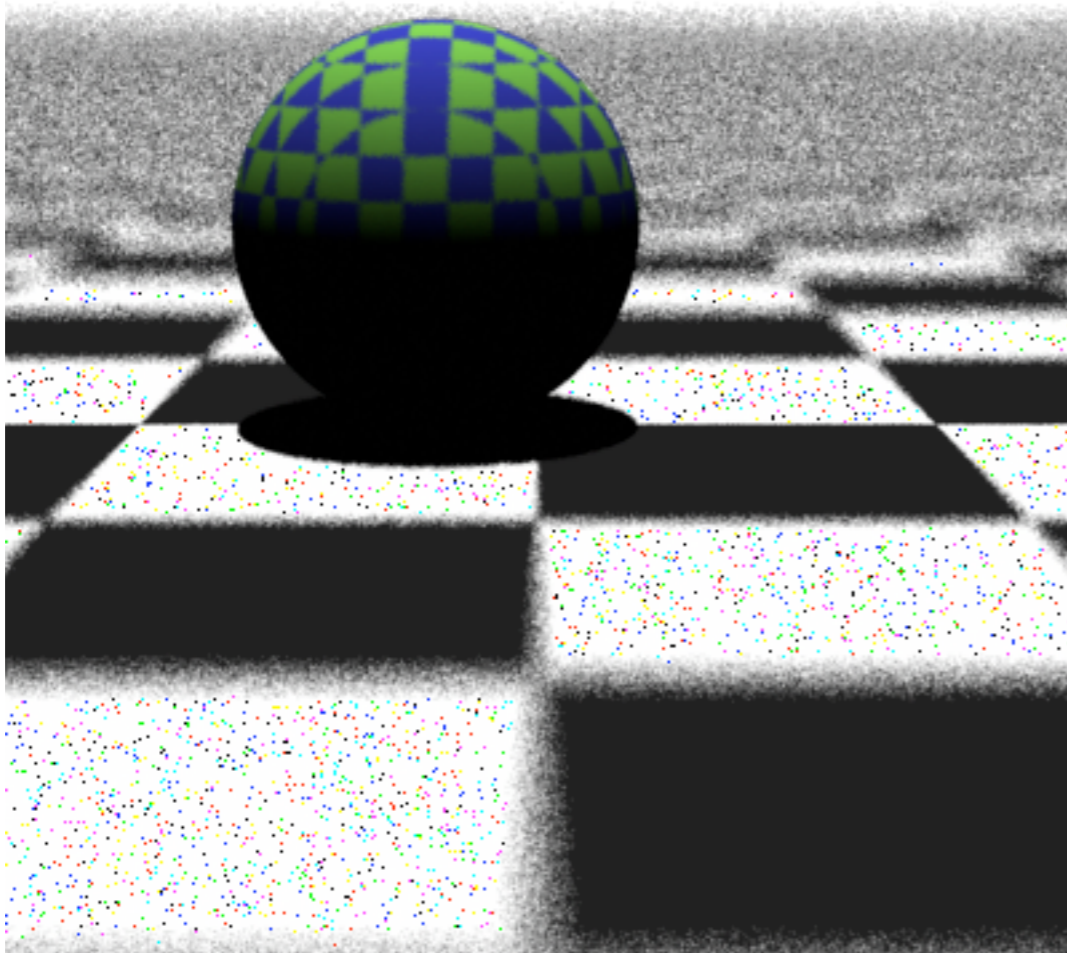
Mitchell & Netravali Filter

- B, C parameters trade off ringing and blurring
- $B=C=1/3$ works well



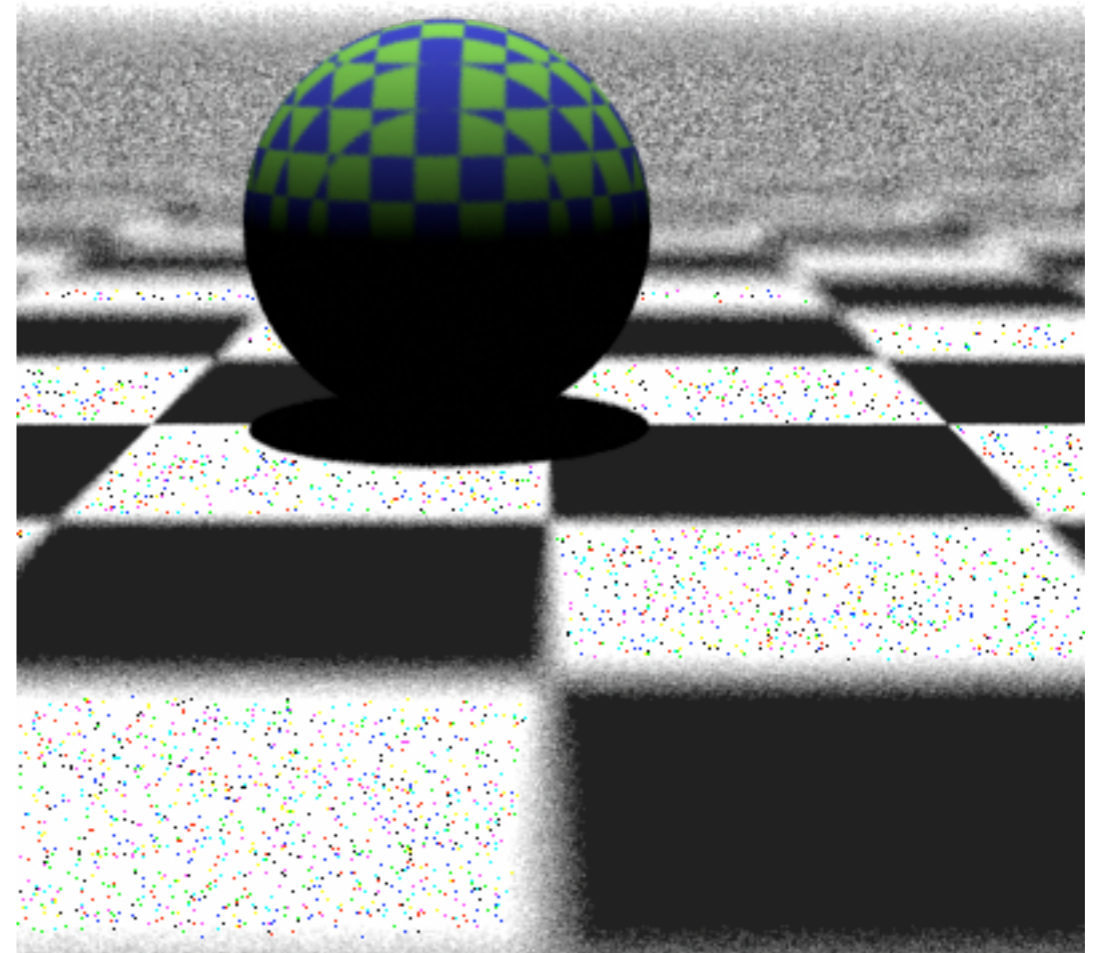
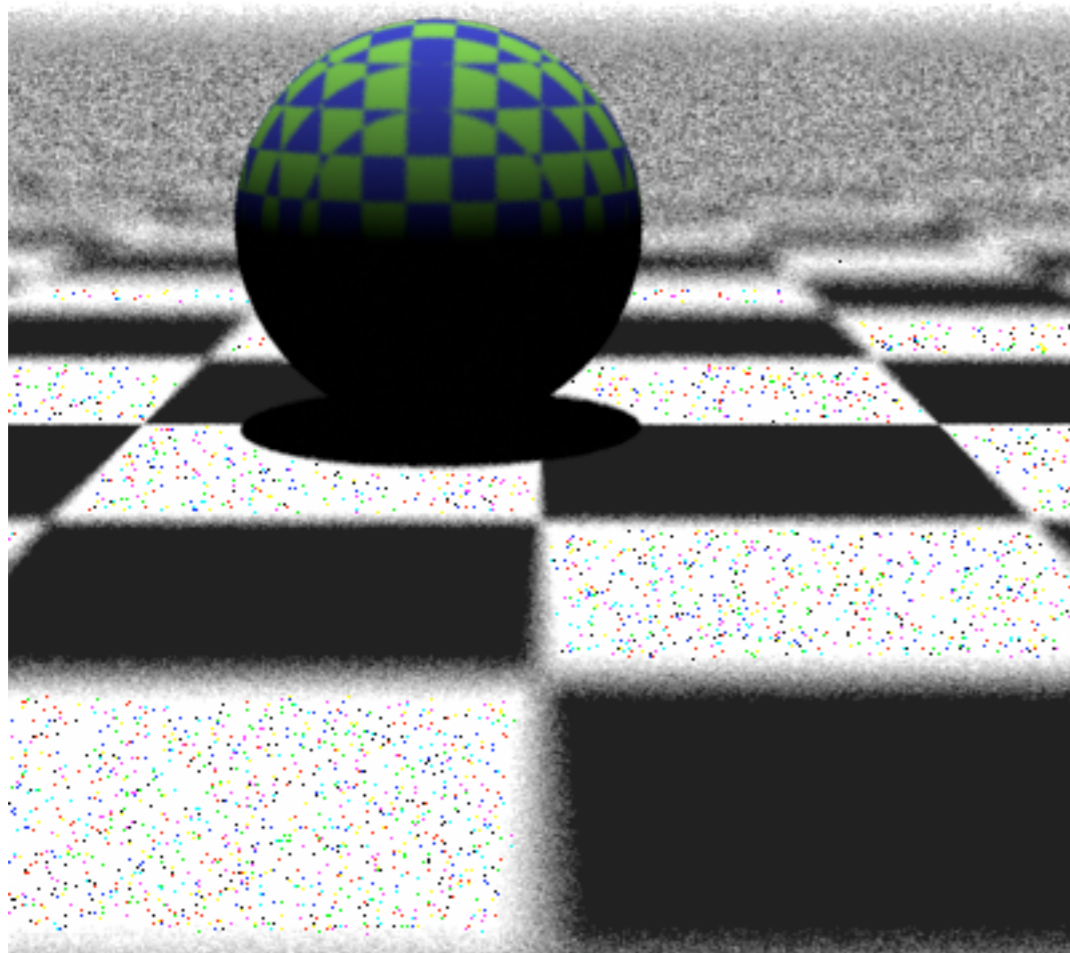
Depth of Field

- Jittered, random vs stratified lens samples



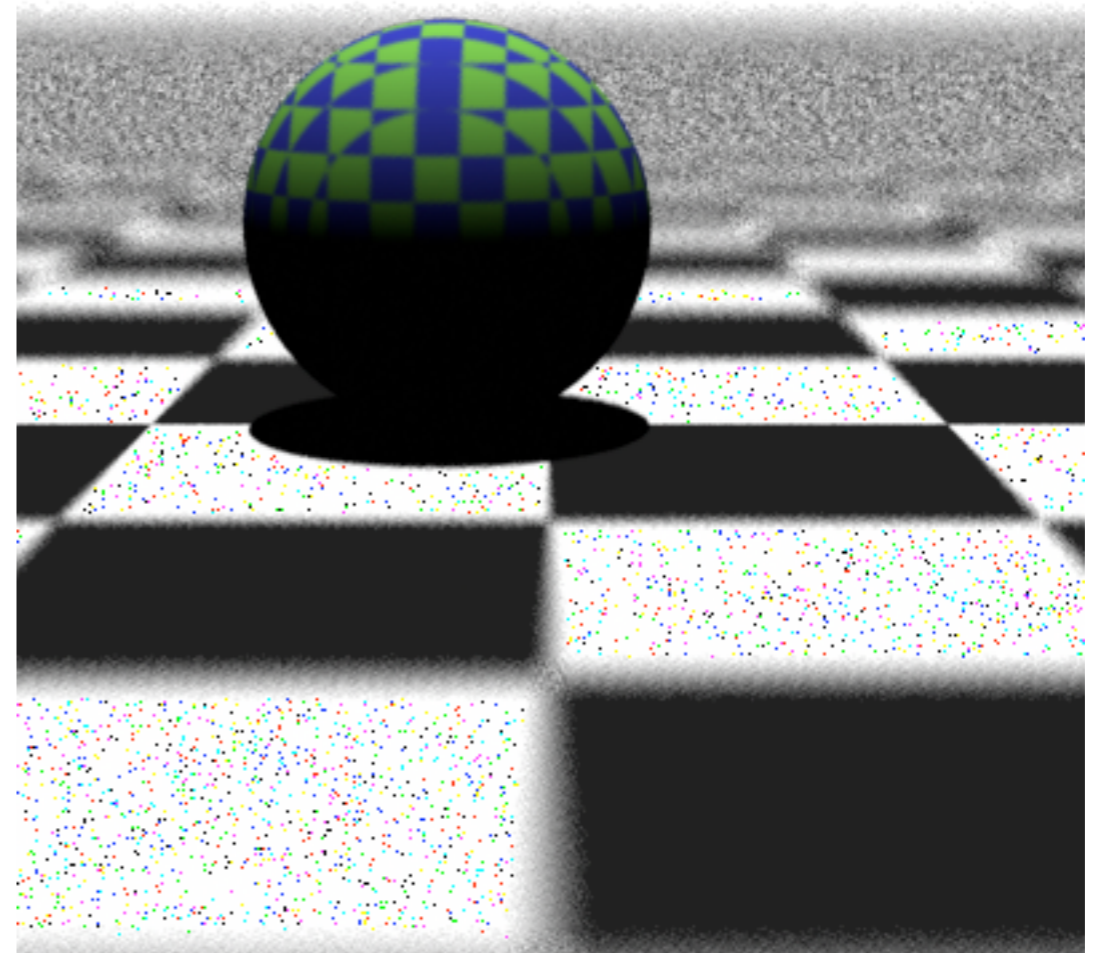
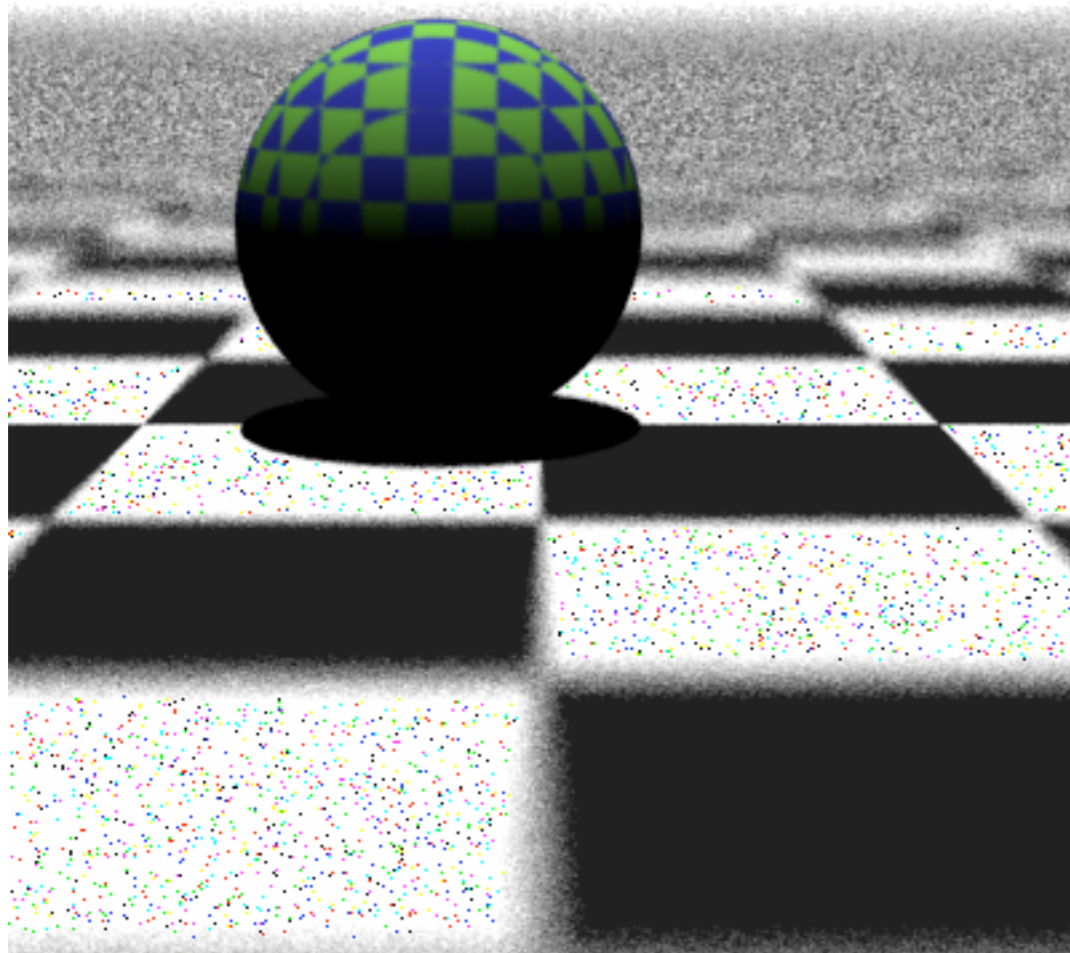
Depth of Field

- Jittered vs Best Candidate



Depth of Field

- Best Candidate vs Low Discrepancy



Adaptive Sampling

- Add samples in areas where aliasing is believed to be happening
- Refinement criteria
 - Edges: primitive id
 - Mitchell '87: Local contrast
 - Bolin & Meyer '96: perceptually based
 - Many others...

Adaptive Sampling

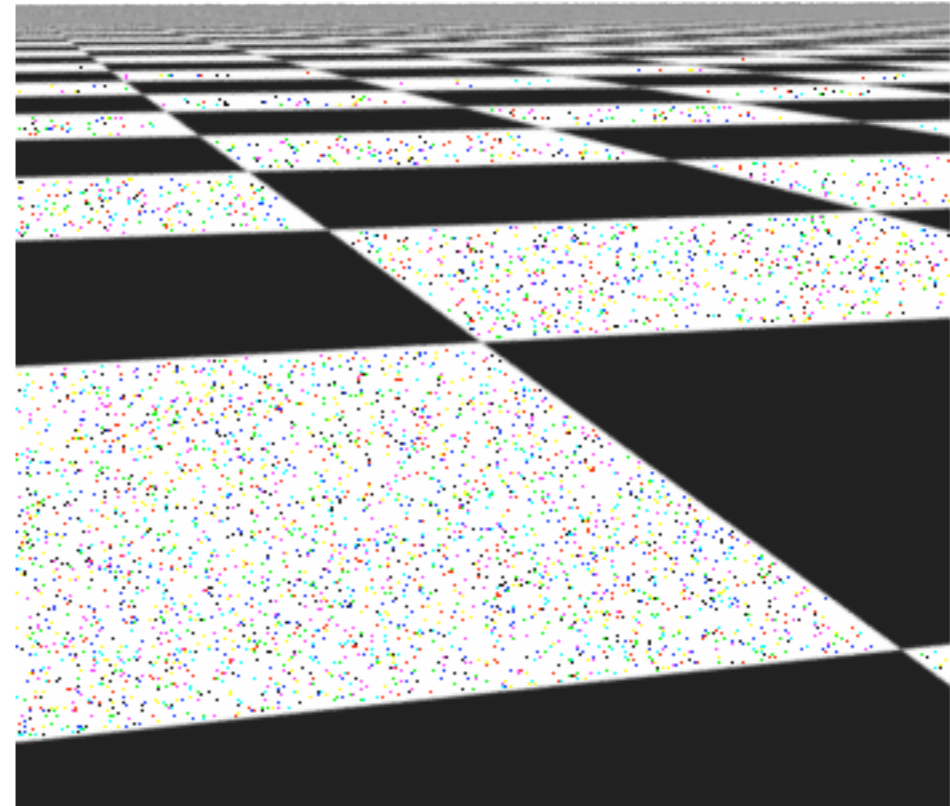
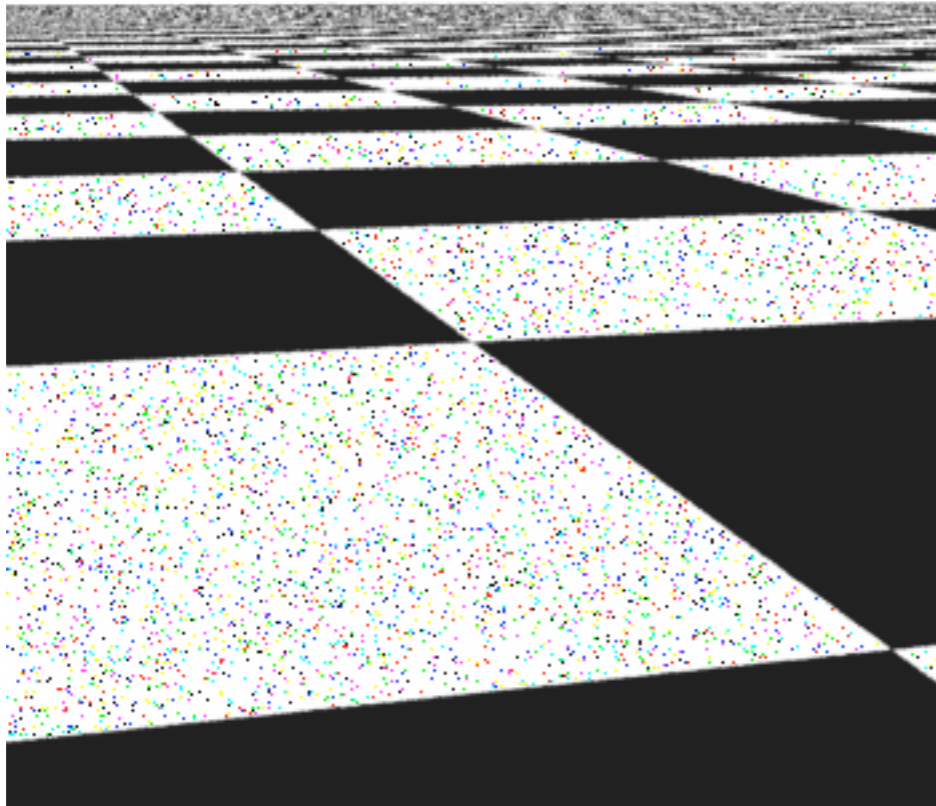
- Pitfalls
 - Reconstruction is tricky
 - Texture anti-aliasing means false positives
 - Bias

Texture Anti-Aliasing

- Three main approaches
 - Pre-filtering
 - Clamping
 - Super-sampling

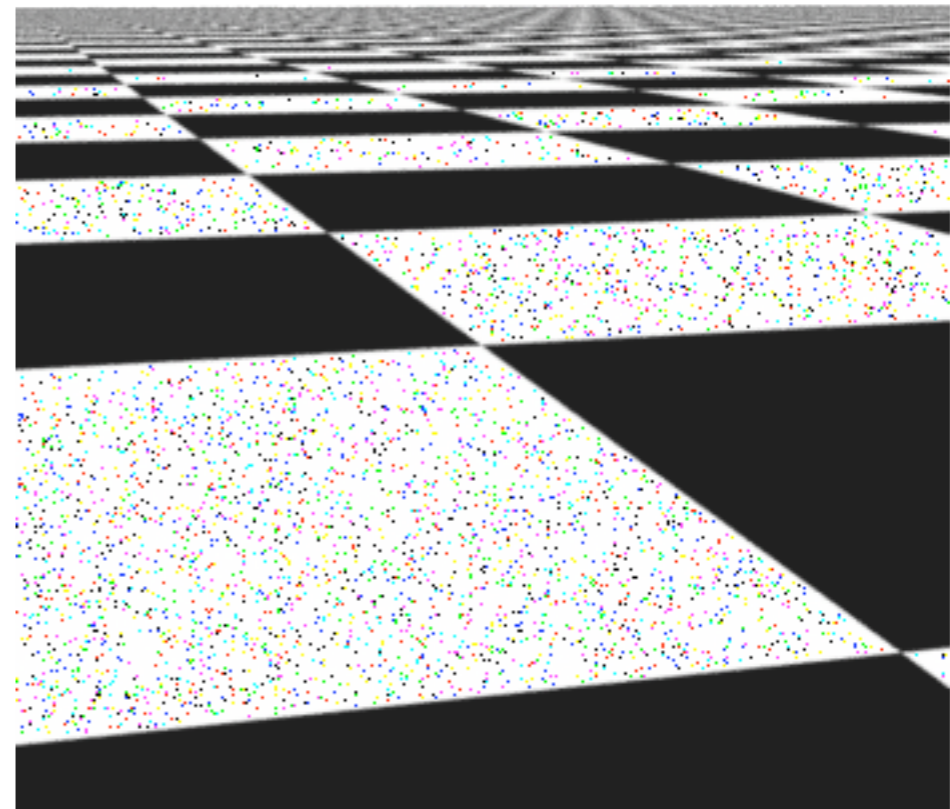
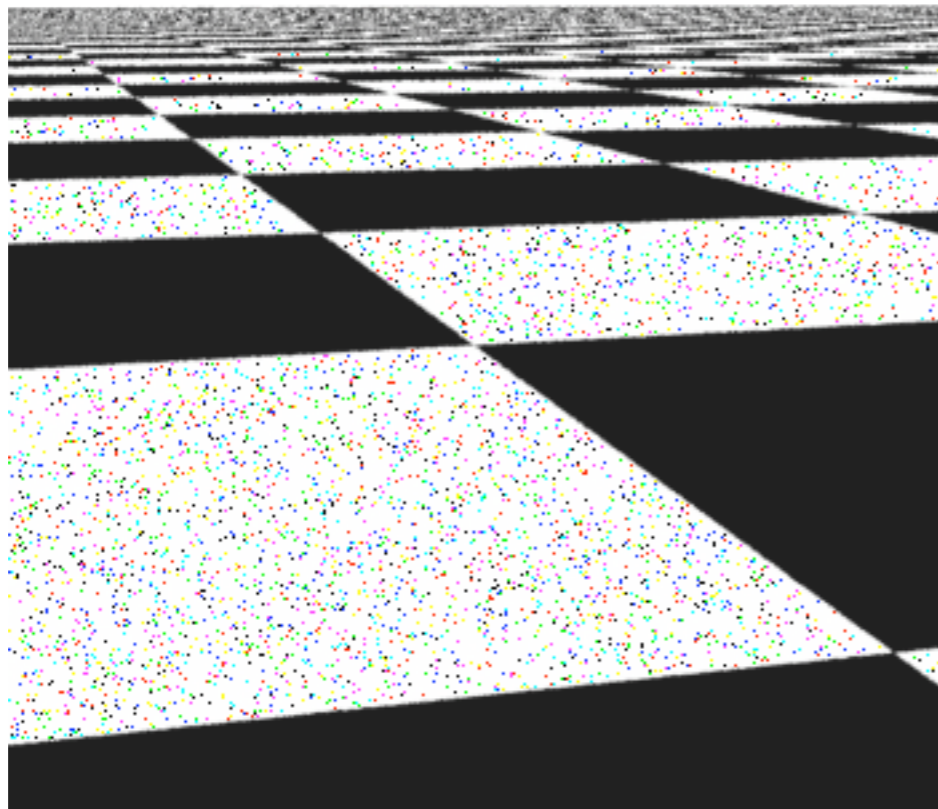
Texture Anti-Aliasing

- 2x2 pixel samples. No A-A versus A-A



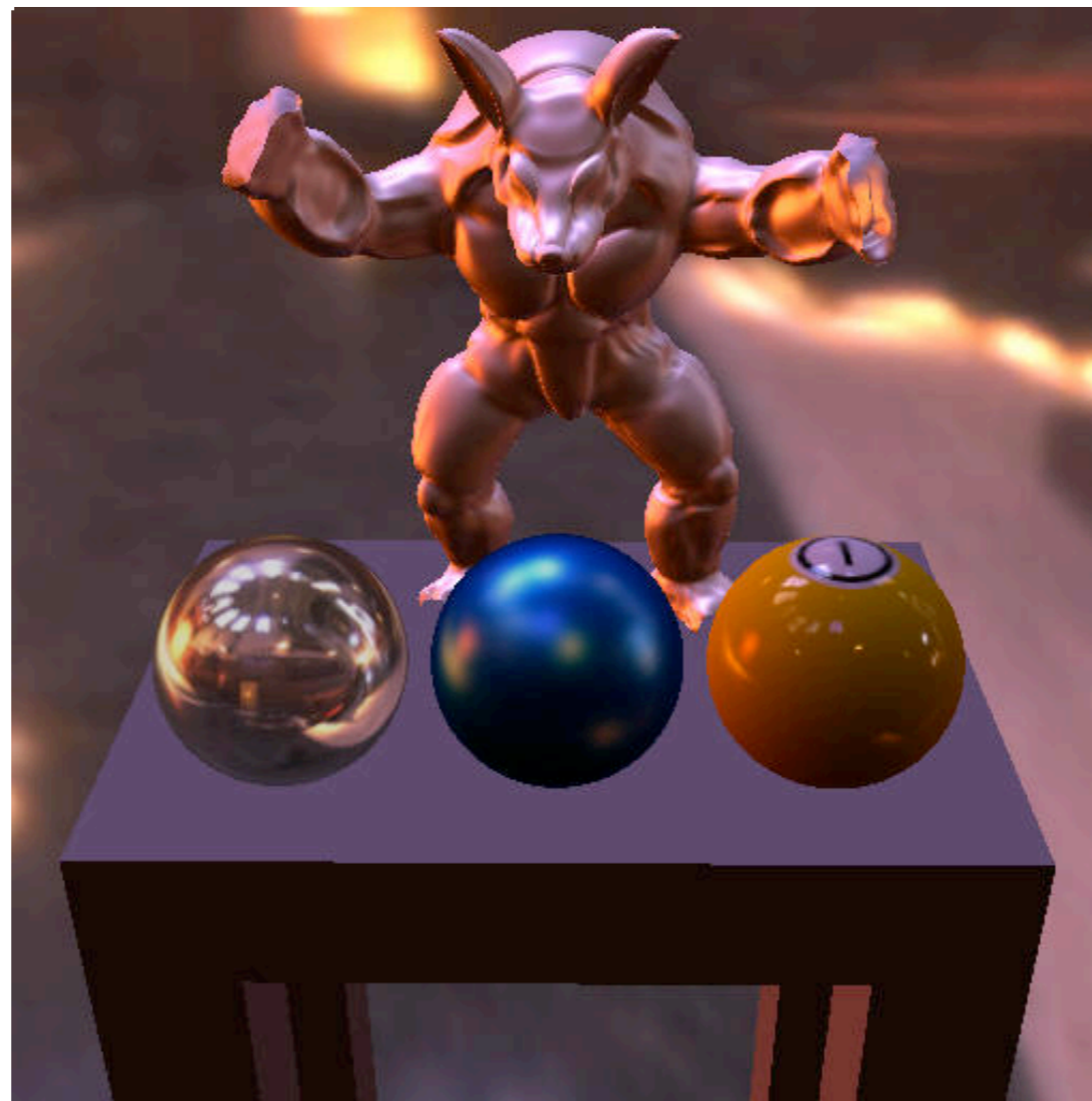
Texture Anti-Aliasing

- No A-A vs. super-sample in texture space



Frequency Space Environment Map Rendering

- Ramamoorthi & Hanrahan, SIGGRAPH '02



Rendering Complex Scenes

- REYES: Cook et al SIGGRAPH '87



Rendering Complex Scenes

- Pharr et al SIGGRAPH '97

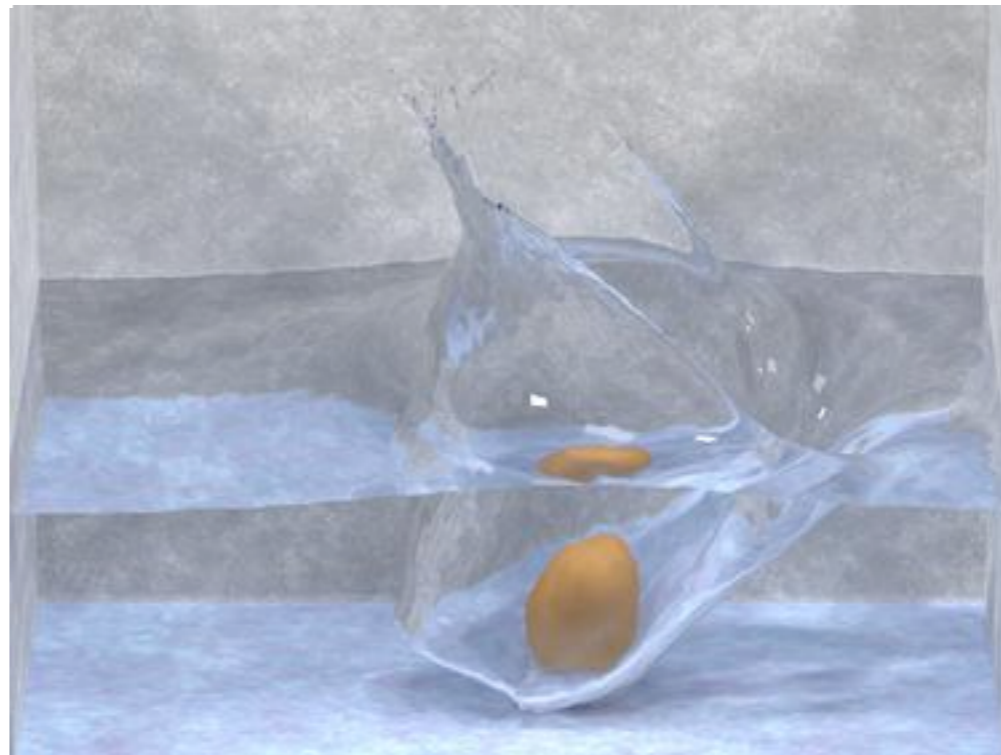


Physically-Based Modeling

- Fedkiw and collaborators



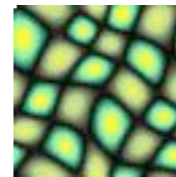
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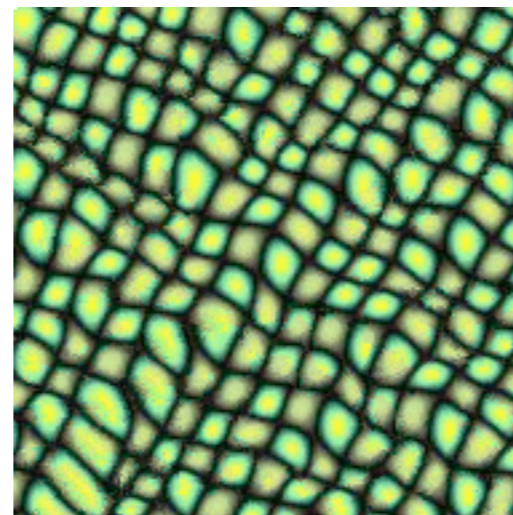
Matt Pharr, Spring 2003

Texture Synthesis

- Many researchers...



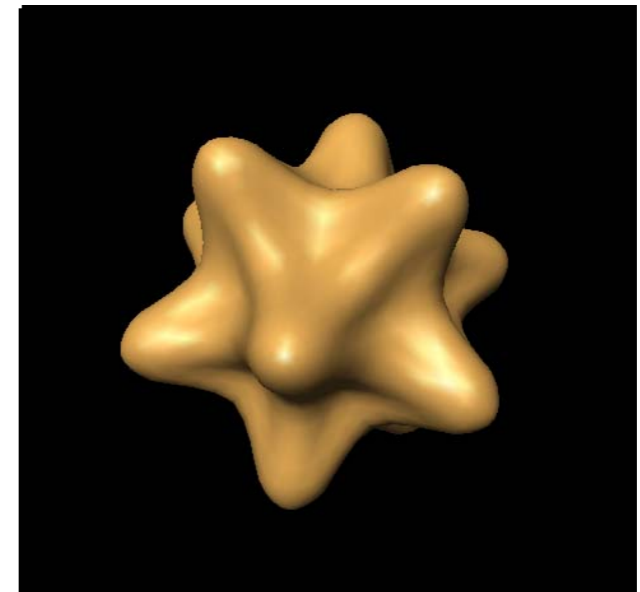
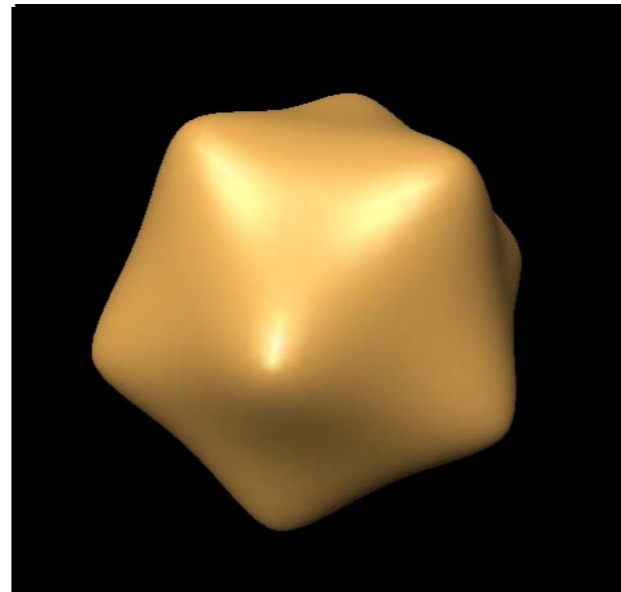
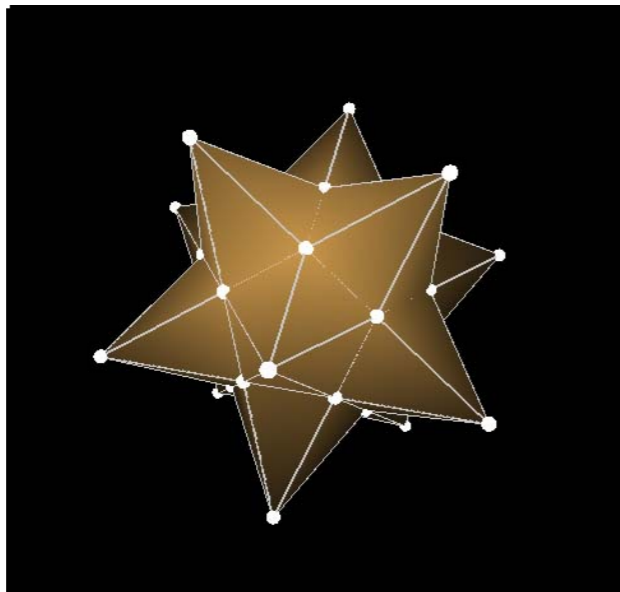
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Surfaces

- Subdivision surfaces (many)



- Mesh simplification
- Progressive meshes (Hoppe)

Procedural Modeling & Texturing

- Ebert et al book
- Prusinkiewicz et al, Deussen and Lintermann



Procedural Modeling



Procedural Modeling



“Non-Photorealistic” Rendering

- Many, esp. at Univ. Washington

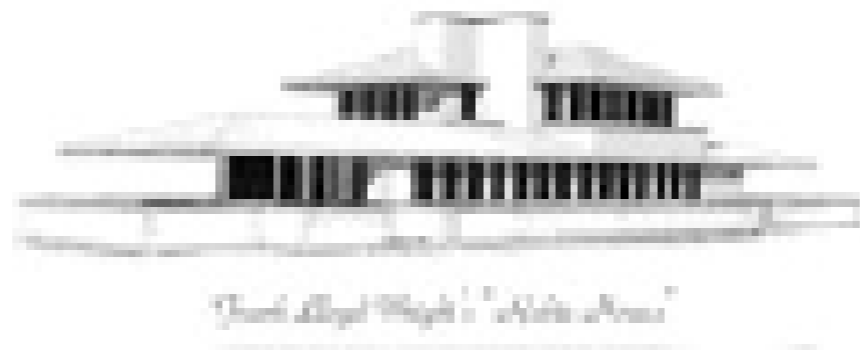


Image Based Rendering

- Chen & Williams '93, Hanrahan & Levoy '96, Gortler et al '96, many others since...

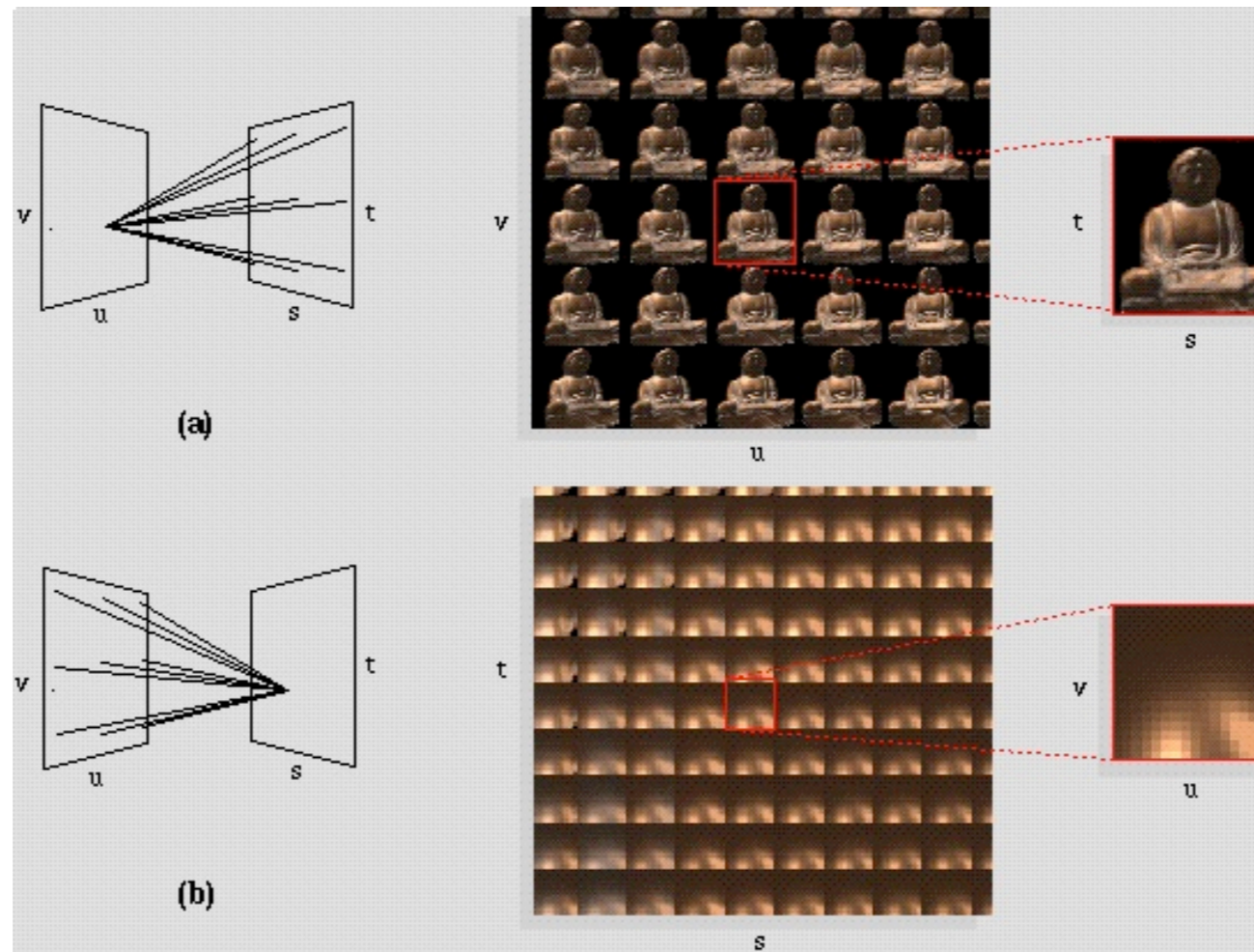


Image Based Rendering

- Layered depth images: Shade et al



Monte Carlo

- Veach PhD thesis



- A parallel SIMD floating-point monster
- Purcell et al: Ray-tracing on GPU
- Mark Harris web page
<http://www.cs.unc.edu/~harrism>