



《计算机图形学》课程

十二、几何（下）

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Mesh Simplification



Mesh Simplification

Goal: reduce number of mesh elements while maintaining the overall shape



30,000 triangles



3,000



300



30

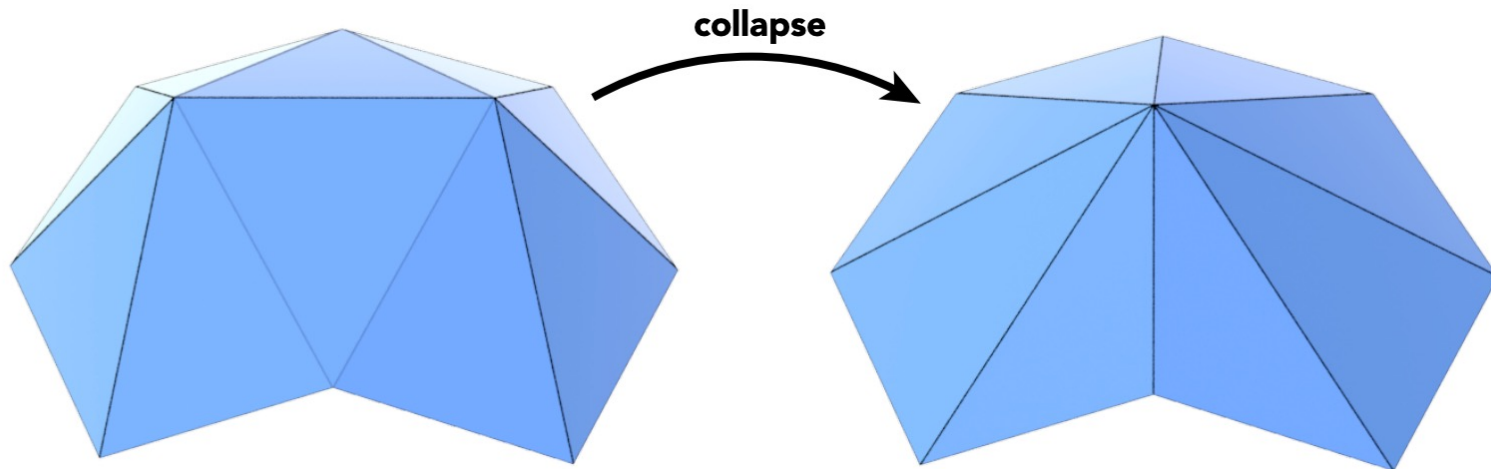


How to compute?



Collapsing An Edge

- Suppose we simplify a mesh using **edge collapsing**

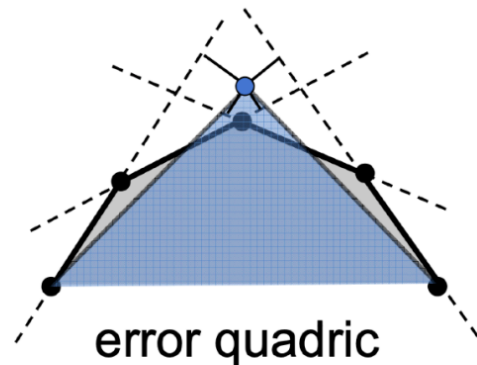
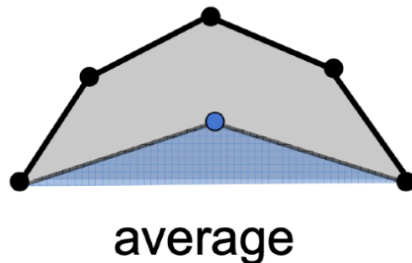




Quadric Error Metrics

(二次误差度量)

- How much geometric error is introduced by simplification?
- Not a good idea to perform local averaging of vertices
- Quadric error: new vertex should minimize its **sum of square distance** (L2 distance) to previously related triangle planes!

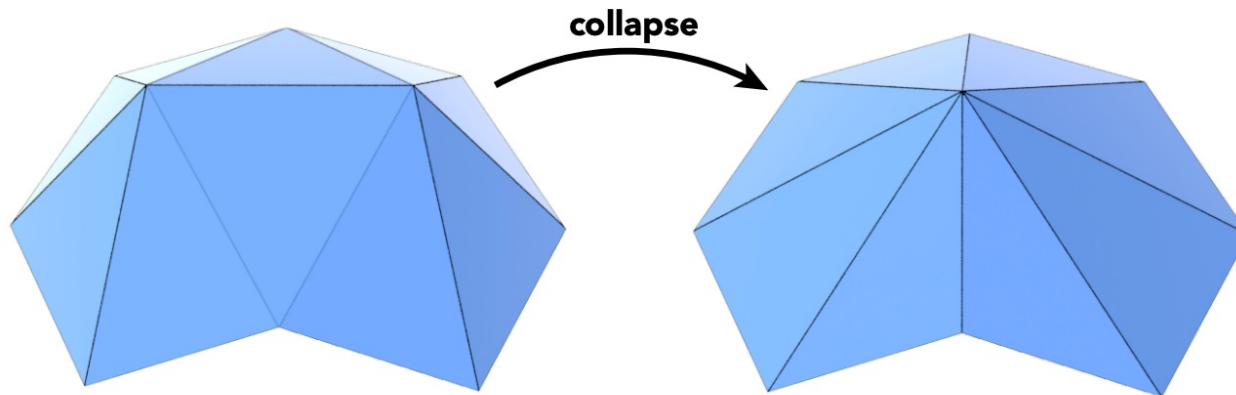


http://graphics.stanford.edu/courses/cs468-10-fall/LectureSlides/08_Simplification.pdf



Quadric Error of Edge Collapse

- How much does it cost to collapse an edge?
- Idea: compute edge midpoint, measure quadric error



- Better idea: choose point that minimizes quadric error
- More details: Garland & Heckbert 1997.



Simplification via Quadric Error

Iteratively collapse edges

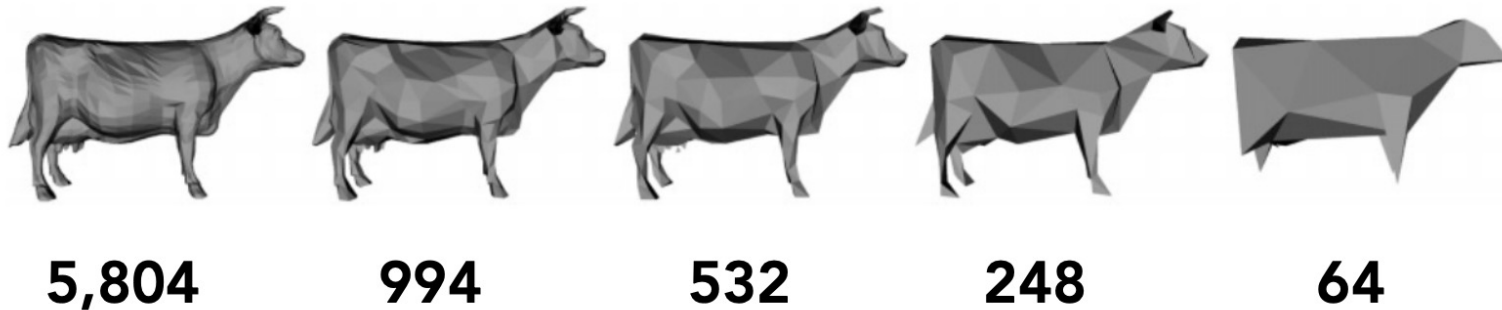
Which edges? Assign score with quadric error metric*

- approximate distance to surface as sum of distances to planes containing triangles
- iteratively collapse edge **with smallest score**
- greedy algorithm... great results!

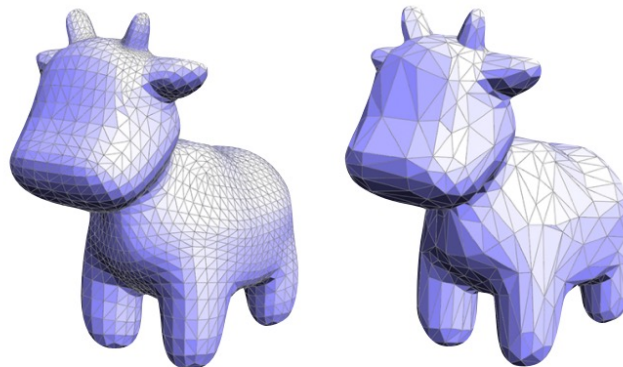
* (Garland & Heckbert 1997)



Quadric Error Mesh Simplification



Garland and Heckbert '97





Before we move on...

- Shadows
 - How to draw shadows using rasterization?
 - **Shadow mapping!**



Shadow of the Tomb Raider, 2018



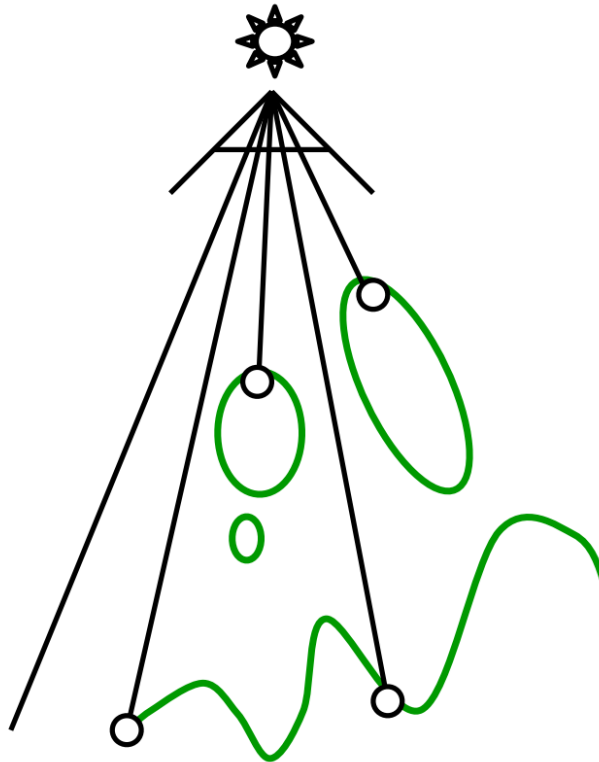
Shadow Mapping

- An Image-space Algorithm
 - no knowledge of scene's geometry during shadow computation
 - must deal with aliasing artifacts
- Key idea:
 - the points NOT in shadow must be seen both **by the light** and **by the camera**



Pass 1: Render from Light

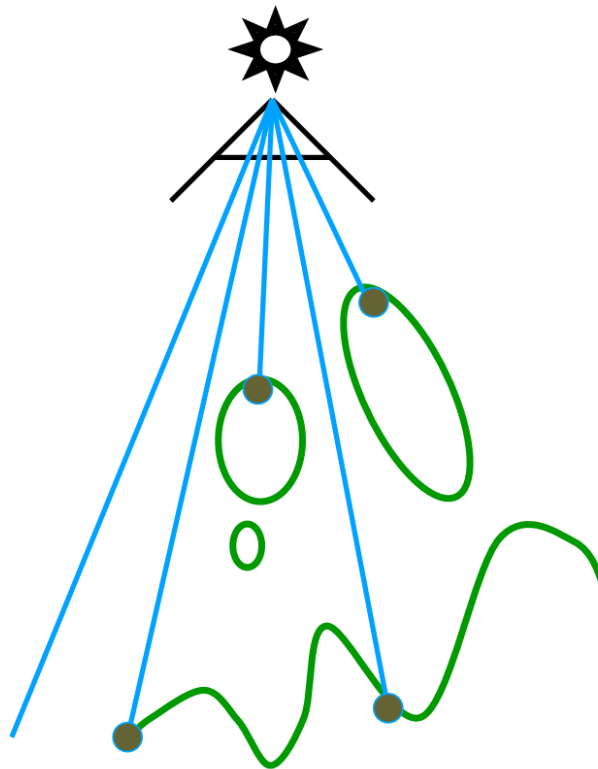
- Depth image from light source





Pass 1: Render from Light

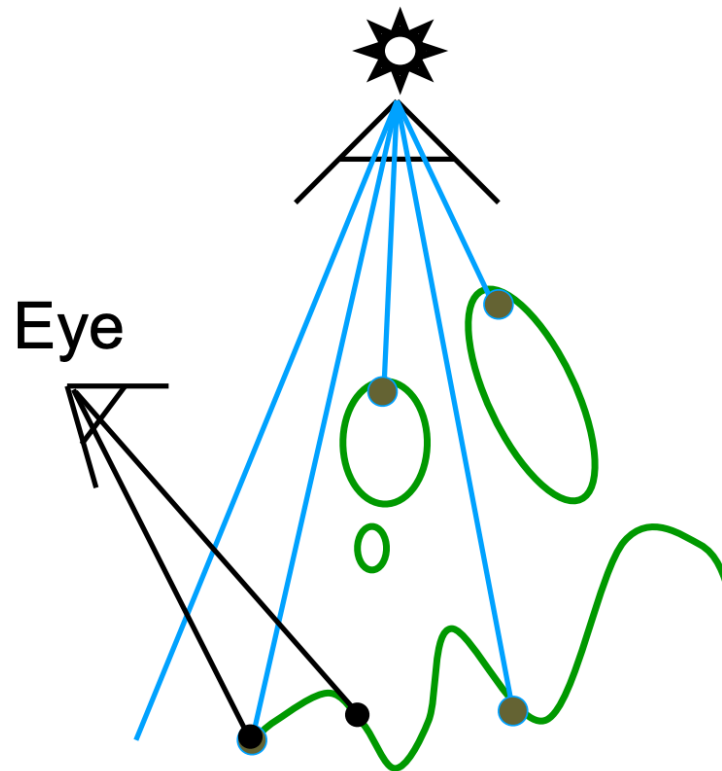
- Depth image from light source





Pass 2A: Render from Eye

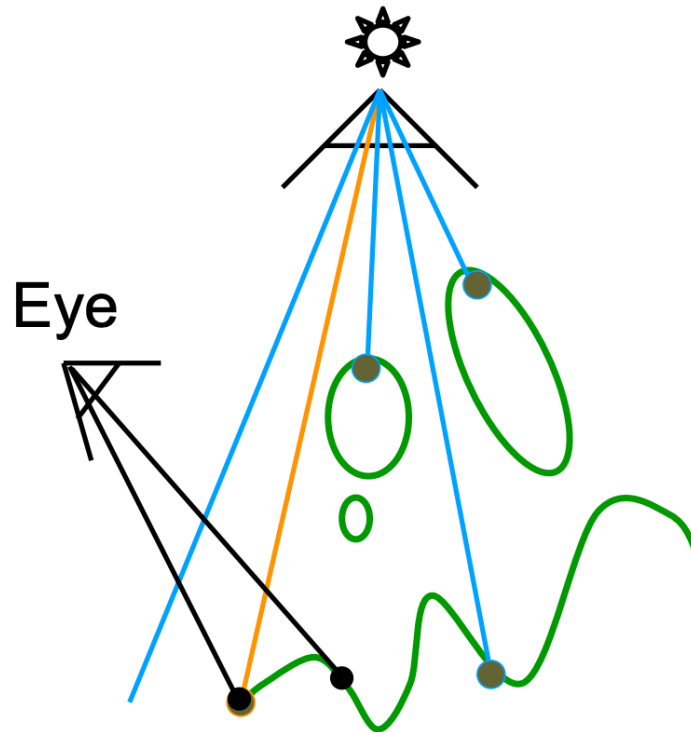
- Standard image (with depth) from eye





Pass 2B: Project to light

- Project visible points in eye view back to light source

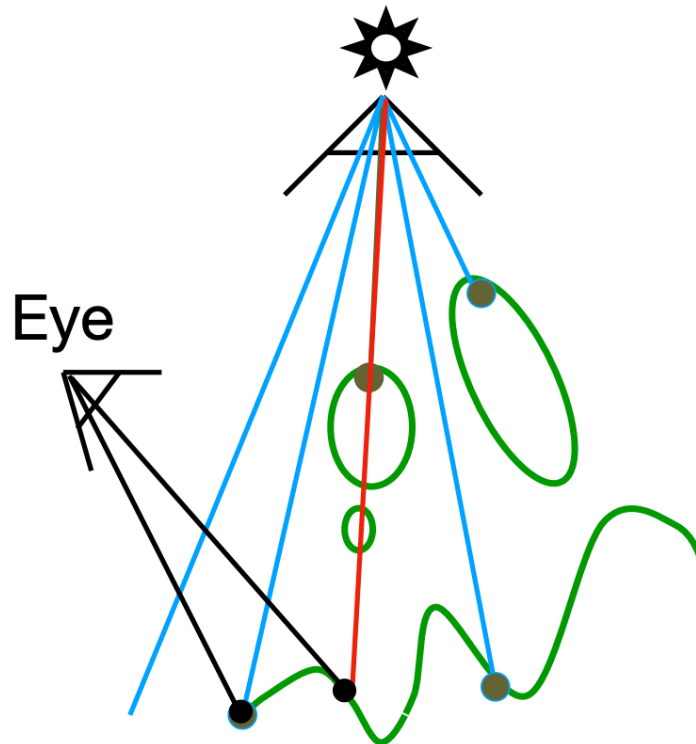


(Reprojected) depths match for light and eye. **VISIBLE**



Pass 2B: Project to light

- Project visible points in eye view back to light source



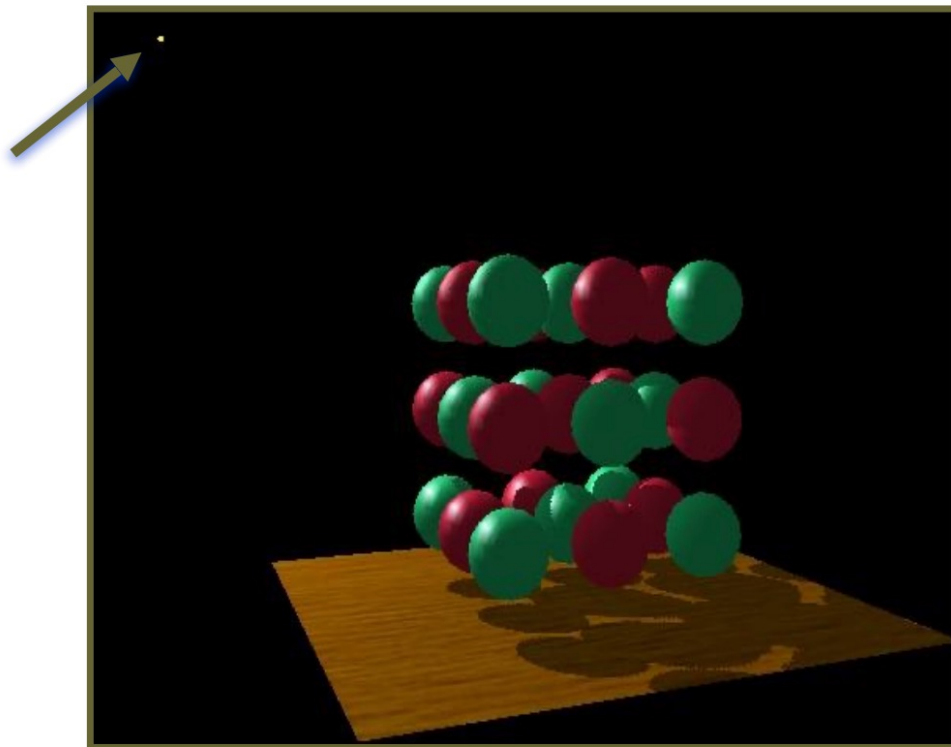
(Reprojected) depths from light and eye are not the same. **BLOCKED!!**



Visualizing Shadow Mapping

- A fairly complex scene with shadows

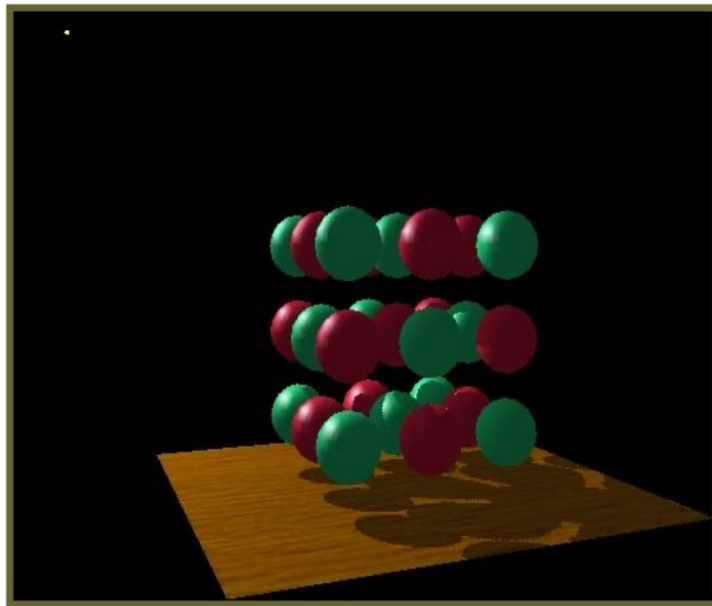
the point
light source



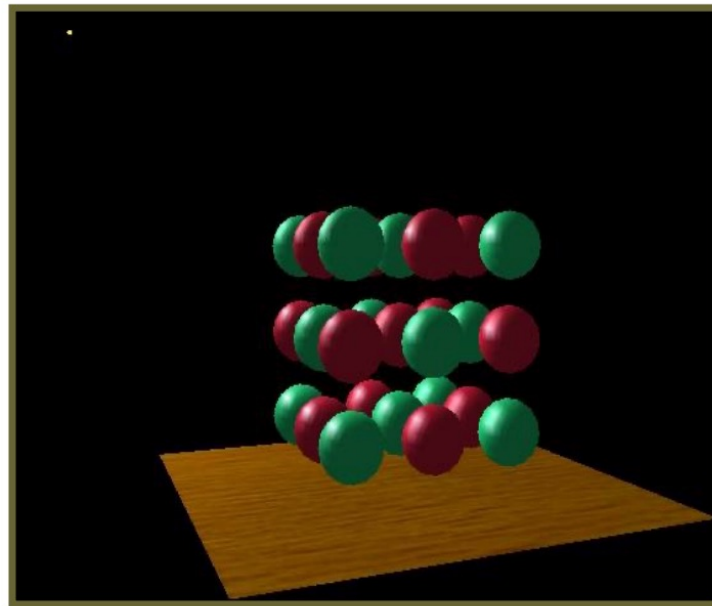


Visualizing Shadow Mapping

- Compare with and without shadows



with shadows

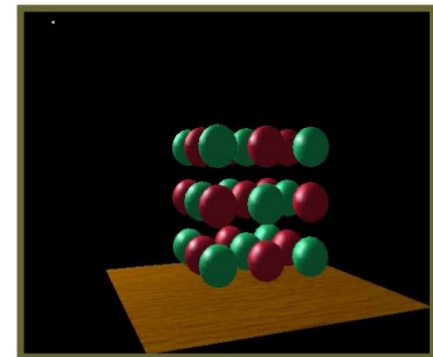
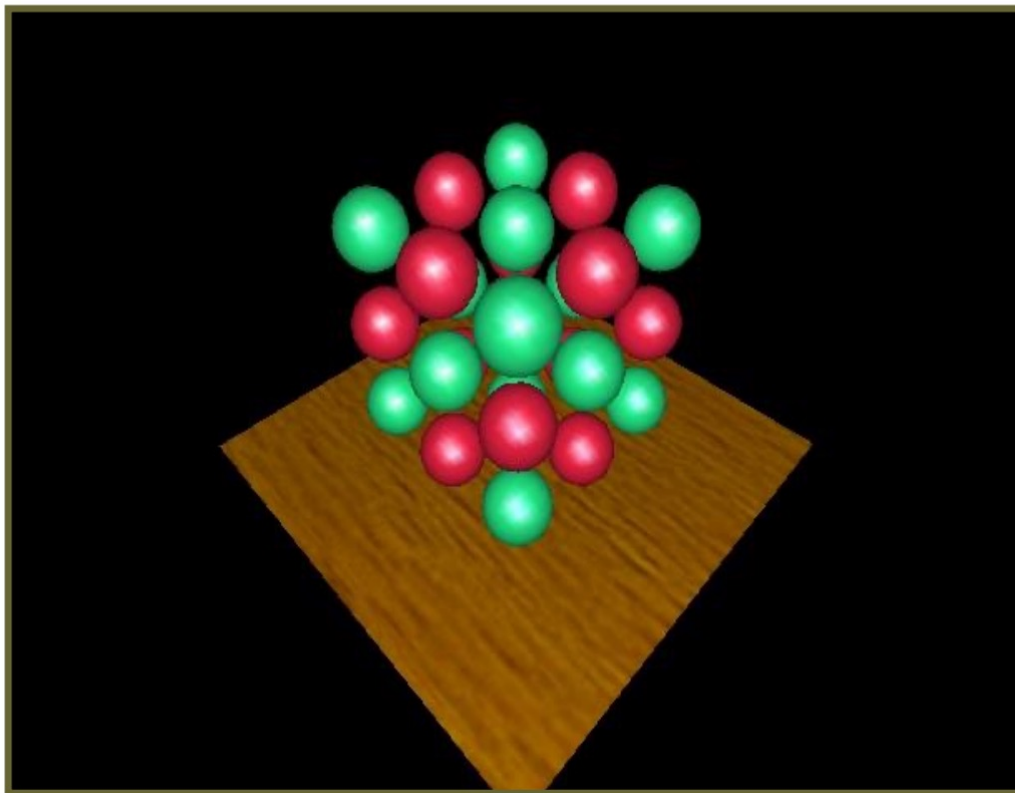


without shadows



Visualizing Shadow Mapping

- The scene from the light's point-of-view

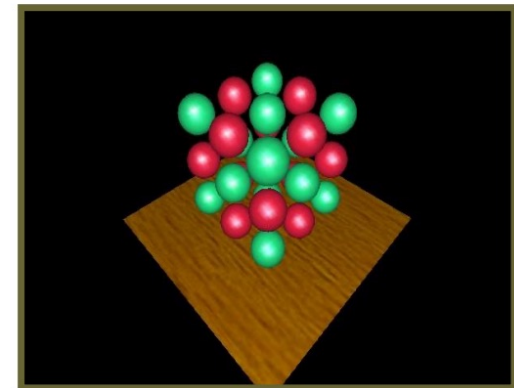
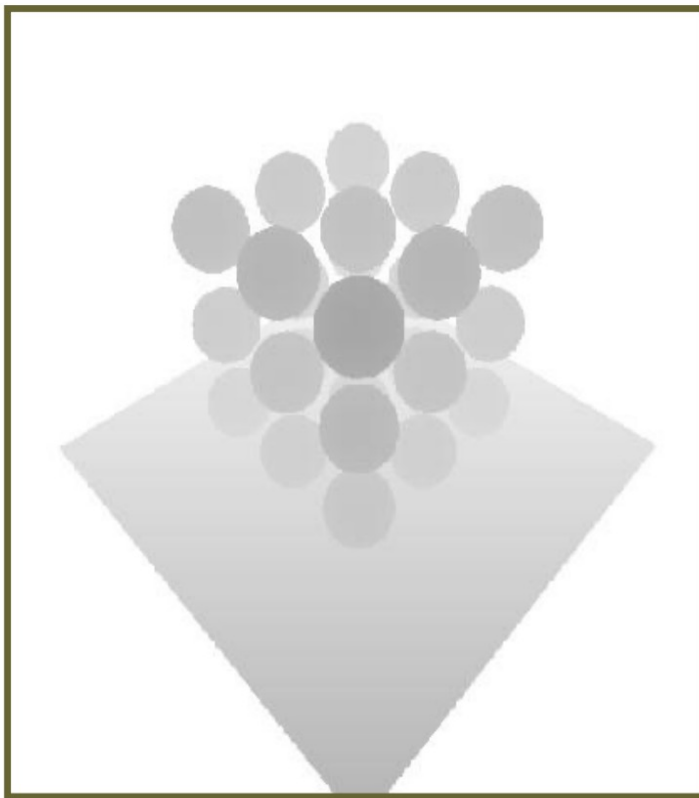


FYI: from the
eye's point-of-view
again



Visualizing Shadow Mapping

- The depth buffer from the light's point-of-view



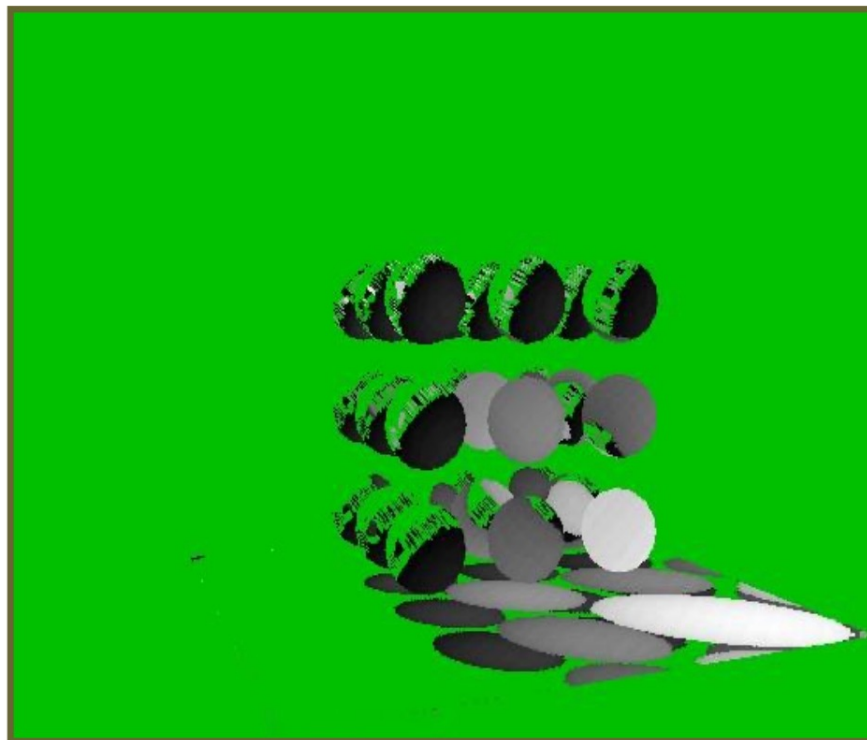
FYI: from the
light's point-of-view
again



Visualizing Shadow Mapping

- Comparing $\text{Dist}(\text{light}, \text{shading point})$ with shadow map

Green is where the
 $\text{distance}(\text{light}, \text{shading point}) \approx$
depth on the
shadow map

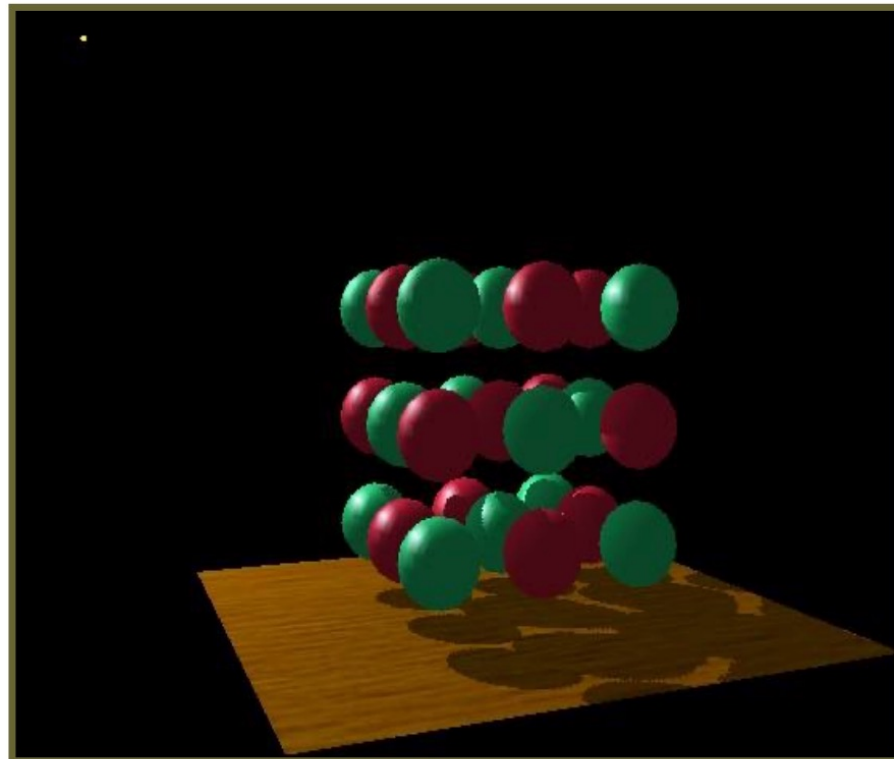


Non-green is where
shadows should be



Visualizing Shadow Mapping

- Scene with shadows





Shadow Mapping

- Well known rendering technique
 - Basic shadowing technique for early animations (Toy Story, etc.) and in EVERY 3D video game



Zelda: Breath of the Wild



Super Mario Odyssey



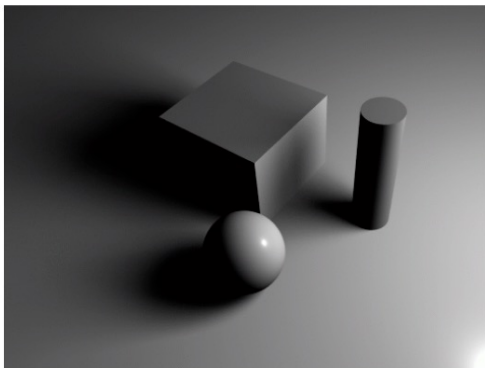
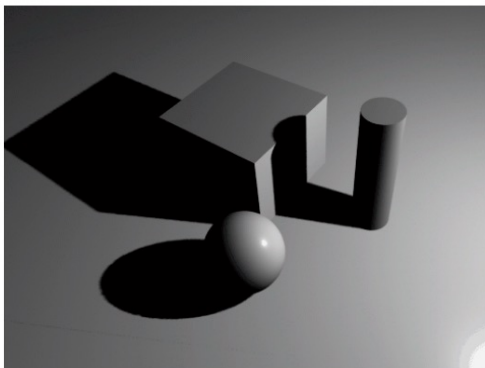
Problems with shadow maps

- Hard shadows (point lights only)
- Quality depends on shadow map resolution
(general problem with image-based techniques)
- Involves equality comparison of floating point depth values means issues of scale, bias, tolerance

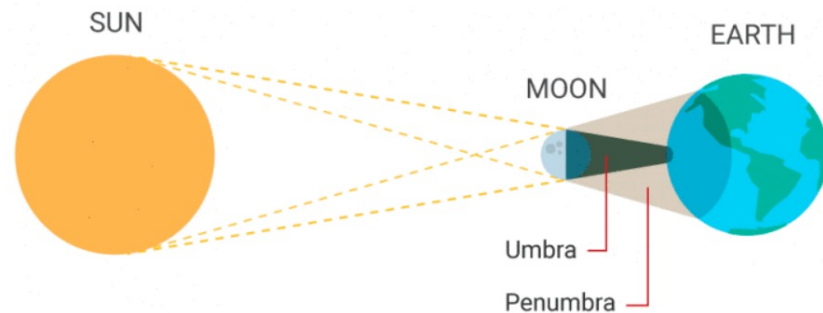


Problems with shadow maps

- Hard shadows vs. soft shadows



[RenderMan]



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[<https://www.timeanddate.com/eclipse/umbra-shadow.html>]



- 网格的简化
 - 边坍缩——二次误差度量
- 光栅化中解决阴影问题
 - Shadow Mapping

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感谢大家的倾听！

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