

CSE 167:
Introduction to Computer Graphics
Lecture #18: Wrapping Up

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Announcements

- ▶ TA evaluations
- ▶ CAPE evaluation
- ▶ Final project blog entries due:
 - ▶ Tuesday, Dec 11th at 11:59pm
- ▶ Video due:
 - ▶ Thursday, Dec 13th at 3pm
- ▶ Final presentation videos will be shown in Center Hall 113

Bump Mapping

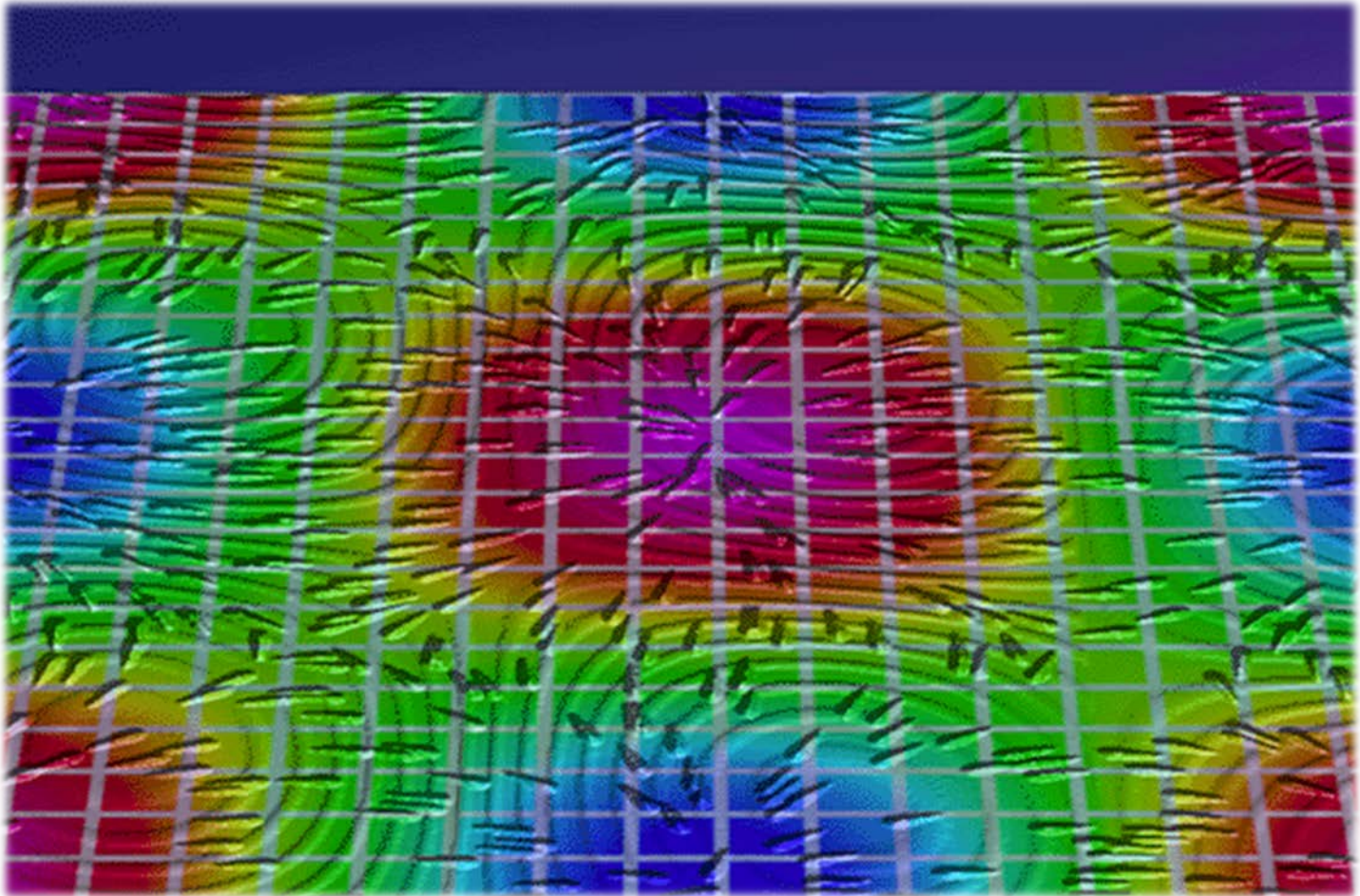
Bump Mapping

- ▶ Many textures are the result of small perturbations in the surface geometry
- ▶ Modeling these changes would result in an explosion in the number of geometric primitives.
- ▶ Bump mapping attempts to alter the lighting across a polygon to provide the illusion of texture.

[This chapter includes slides by Roger Crawfis]



Bump Mapping Example

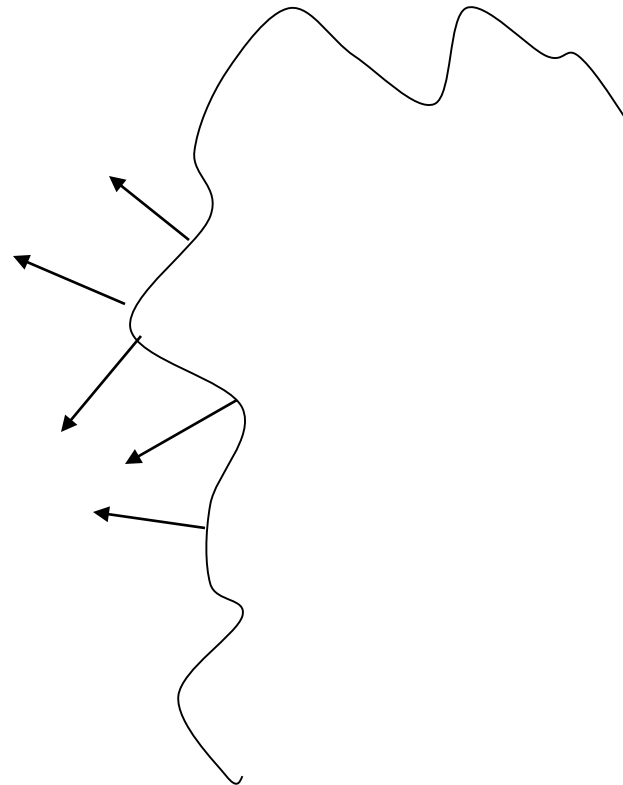


Crawfis 1991



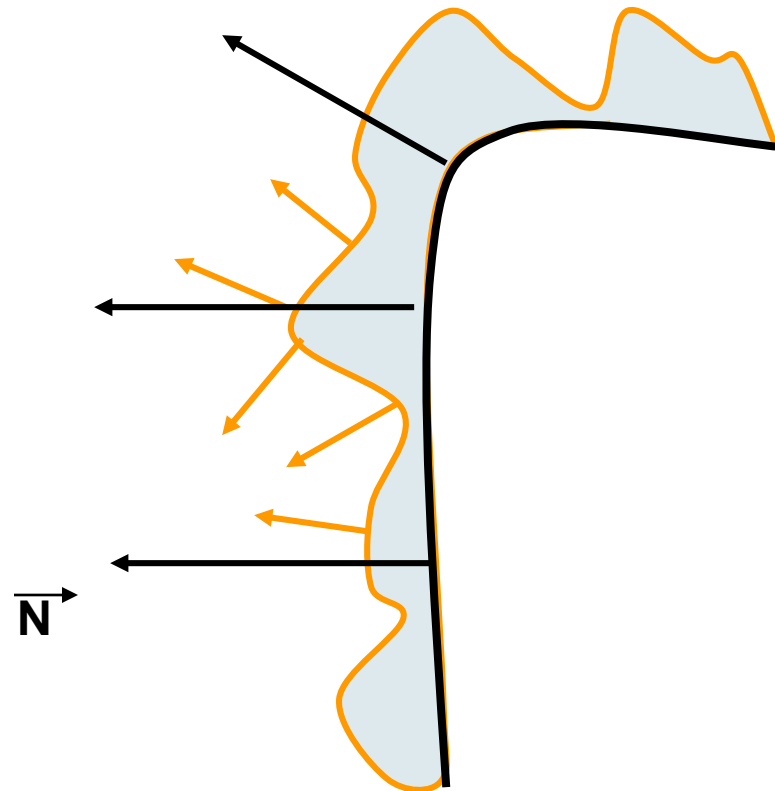
Bump Mapping

- ▶ Consider the lighting for a modeled surface.



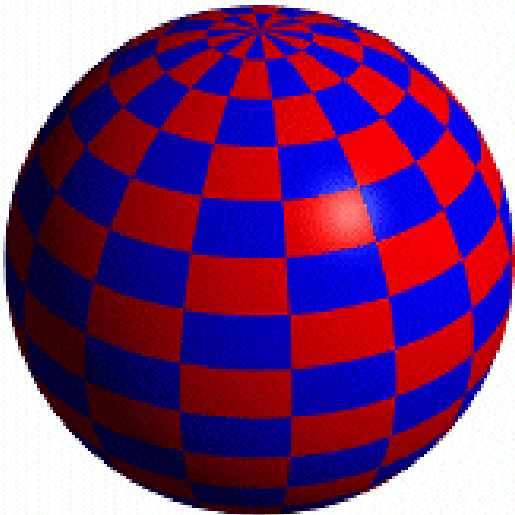
Bump Mapping

- ▶ We can model this as deviations from some base surface.
- ▶ The question is then how these deviations change the lighting.

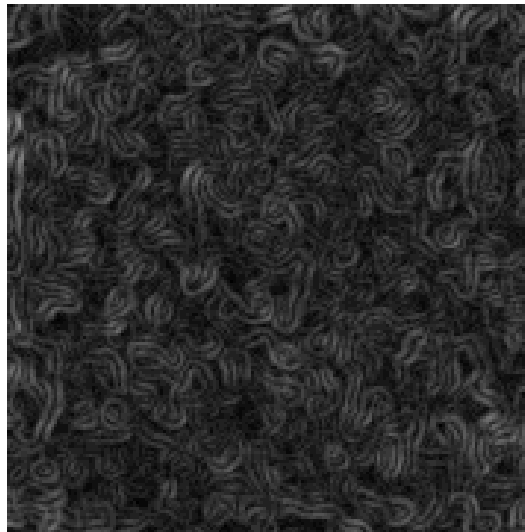


Bump Mapping

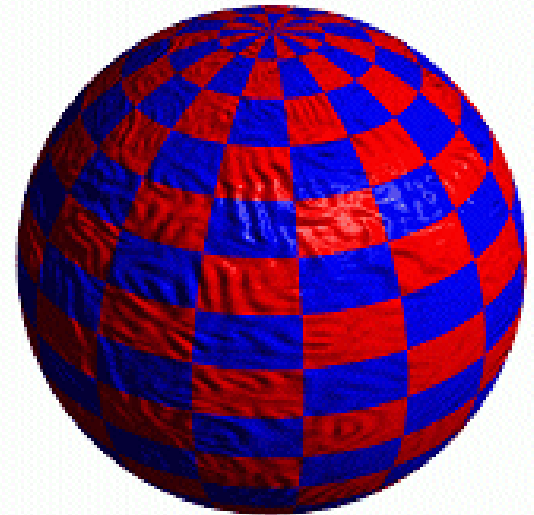
- ▶ Store in a texture and use textures to alter the surface normal
 - ▶ Does not change the shape of the surface
 - ▶ Just shaded as if it were a different shape



Sphere w/Diffuse Texture



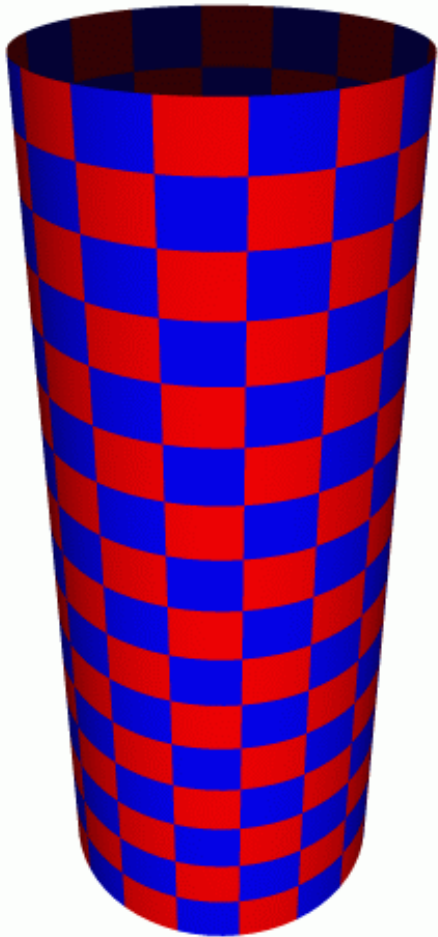
Swirly Bump Map



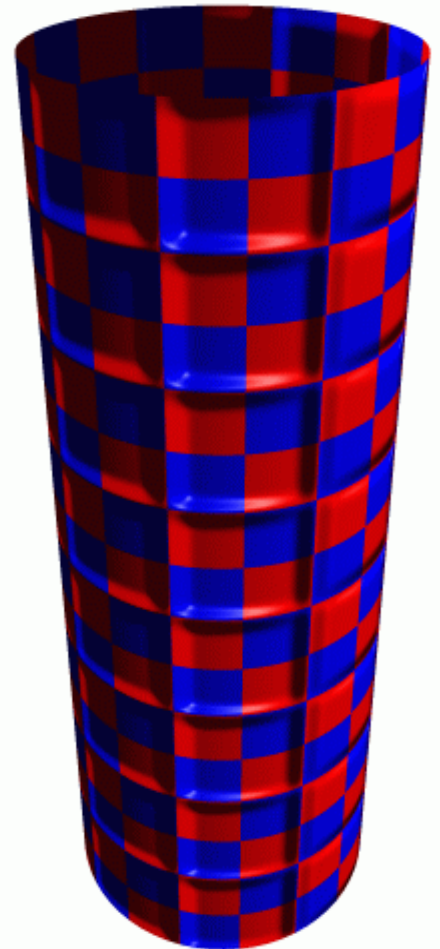
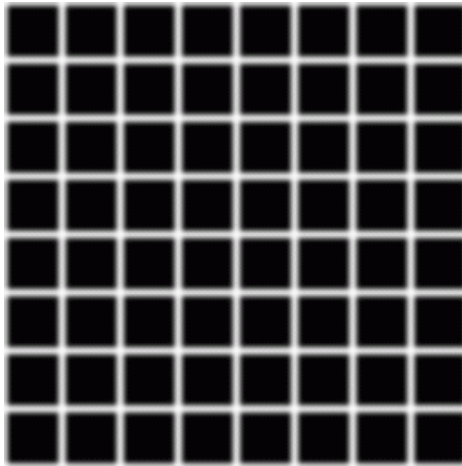
Sphere w/Diffuse Texture & Bump Map



Simple textures work great

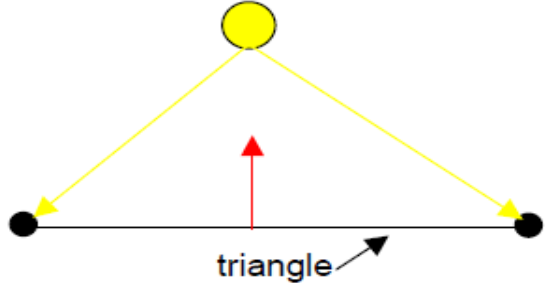
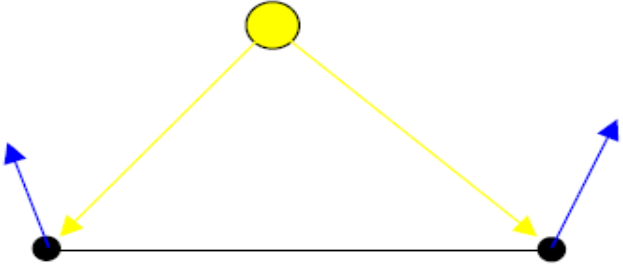
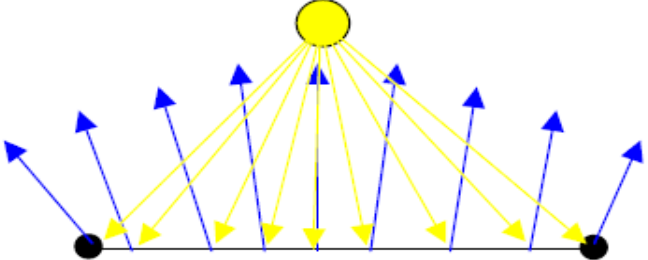
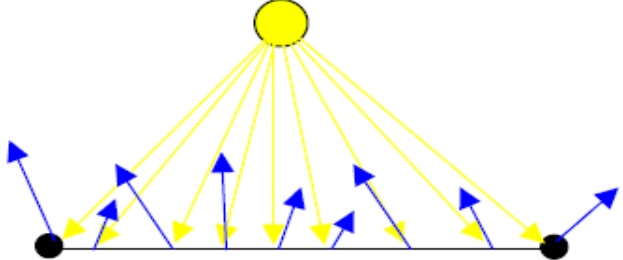


Cylinder w/Diffuse Texture Map



Cylinder w/Texture Map & Bump Map

Normal Mapping

Flat shading	Gouraud shading
 <p>Only the first normal of the triangle is used to compute lighting in the entire triangle.</p>	 <p>The light intensity is computed at each vertex and interpolated across the surface.</p>
Phong shading	Bump mapping
 <p>Normals are interpolated across the surface, and the light is computed at each fragment.</p>	 <p>Normals are stored in a bumpmap texture, and used instead of Phong normals.</p>



Normal Mapping



Just texture mapped



Texture and normal maps

Notice: The geometry is unchanged. There's the same number of vertices and triangles. This effect is entirely from the normal map.



Normal Maps



Diffuse Color Texture Map

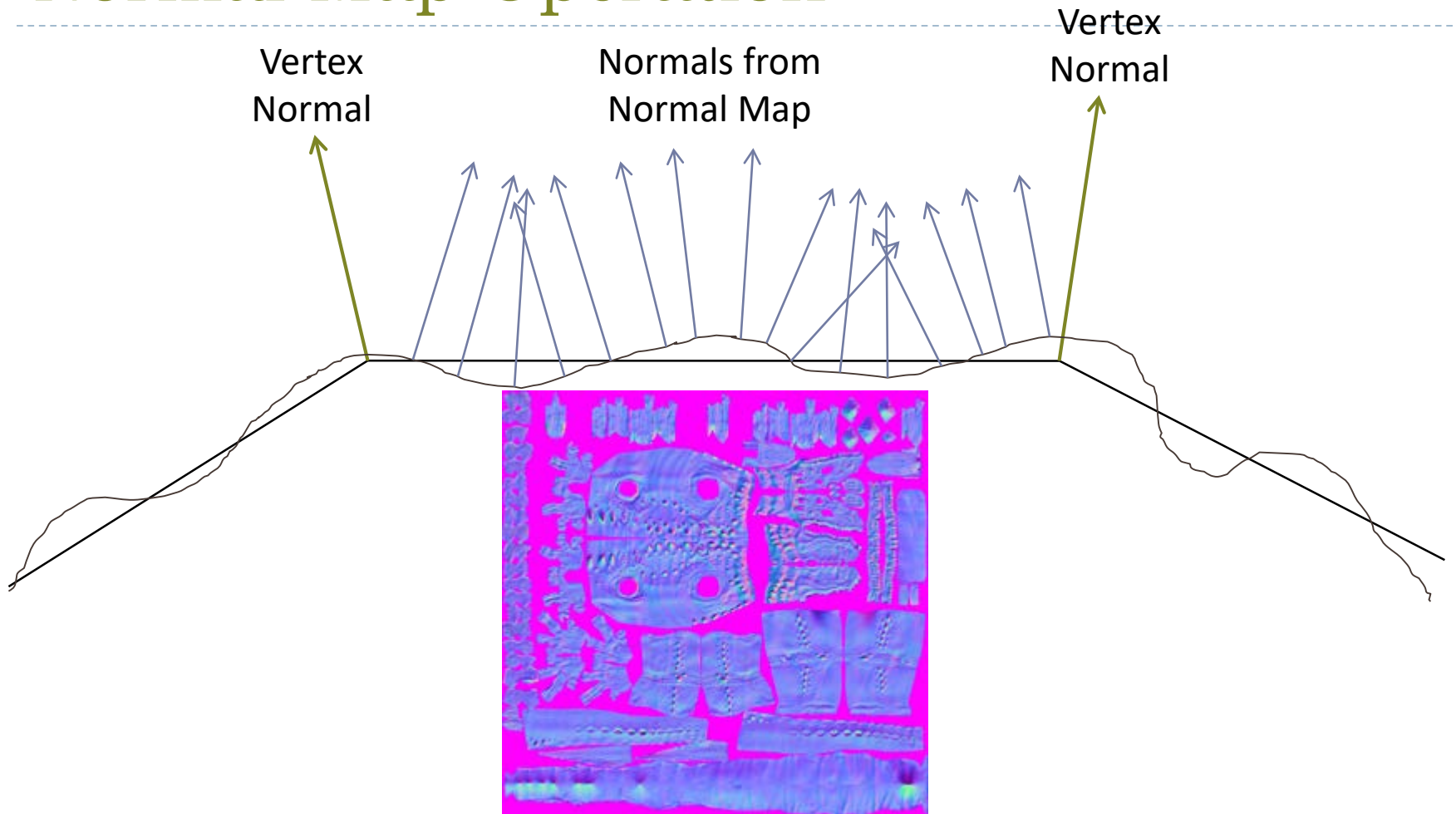
Normal Map

Each pixel represents a normal vector relative to the surface at that point. -1 to 1 range is mapped to 0 to 1 for the texture so normals become colors.

→ Inverse of Normal Coloring



Normal Map Operation



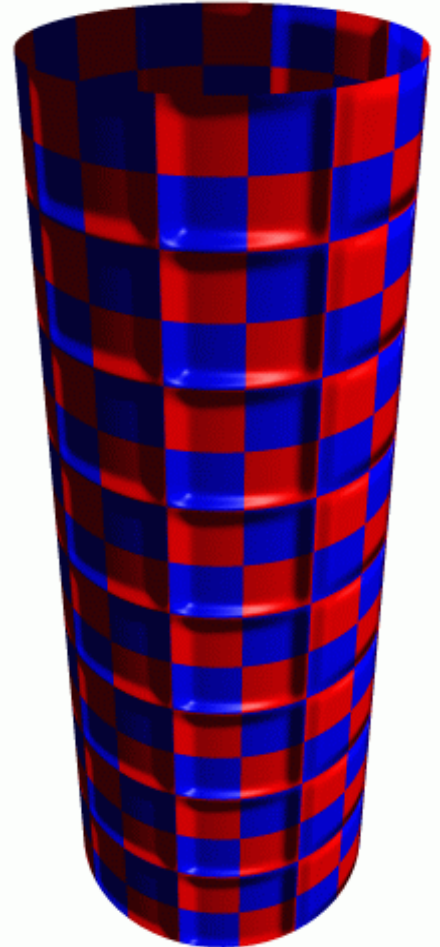
For each pixel, determine the normal from a texture image. Use that to compute the color.



What's Missing?

- ▶ There are no bumps on the silhouette of a bump or normal-mapped object

→ Displacement Mapping



What Next?

Graphics Courses

- ▶ CSE 167: Introduction to CG (Schulze, Ramamoorthi) – Fall and Winter
- ▶ CSE 165: 3D User Interfaces (Schulze) – Winter
- ▶ CSE 169: Animation (Rotenberg) – Winter 2019
- ▶ CSE 190: Virtual Reality (Schulze) – Spring

Computer Graphics State of The Art

- ▶ **ACM SIGGRAPH Asia 2018 Technical Papers (4'10)**
 - ▶ https://www.youtube.com/watch?v=wdKpXvF_3AU
- ▶ **CRYENGINE V - Hunt: Showdown Tech Demo GDC 18 (2'11)**
 - ▶ <https://www.youtube.com/watch?v=Ffxd-vFspcs>
- ▶ **2018 Student Reel | Unreal Engine (3'19)**
 - ▶ <https://www.youtube.com/watch?v=zfPSBcyIPpU>

Good luck with your final projects!