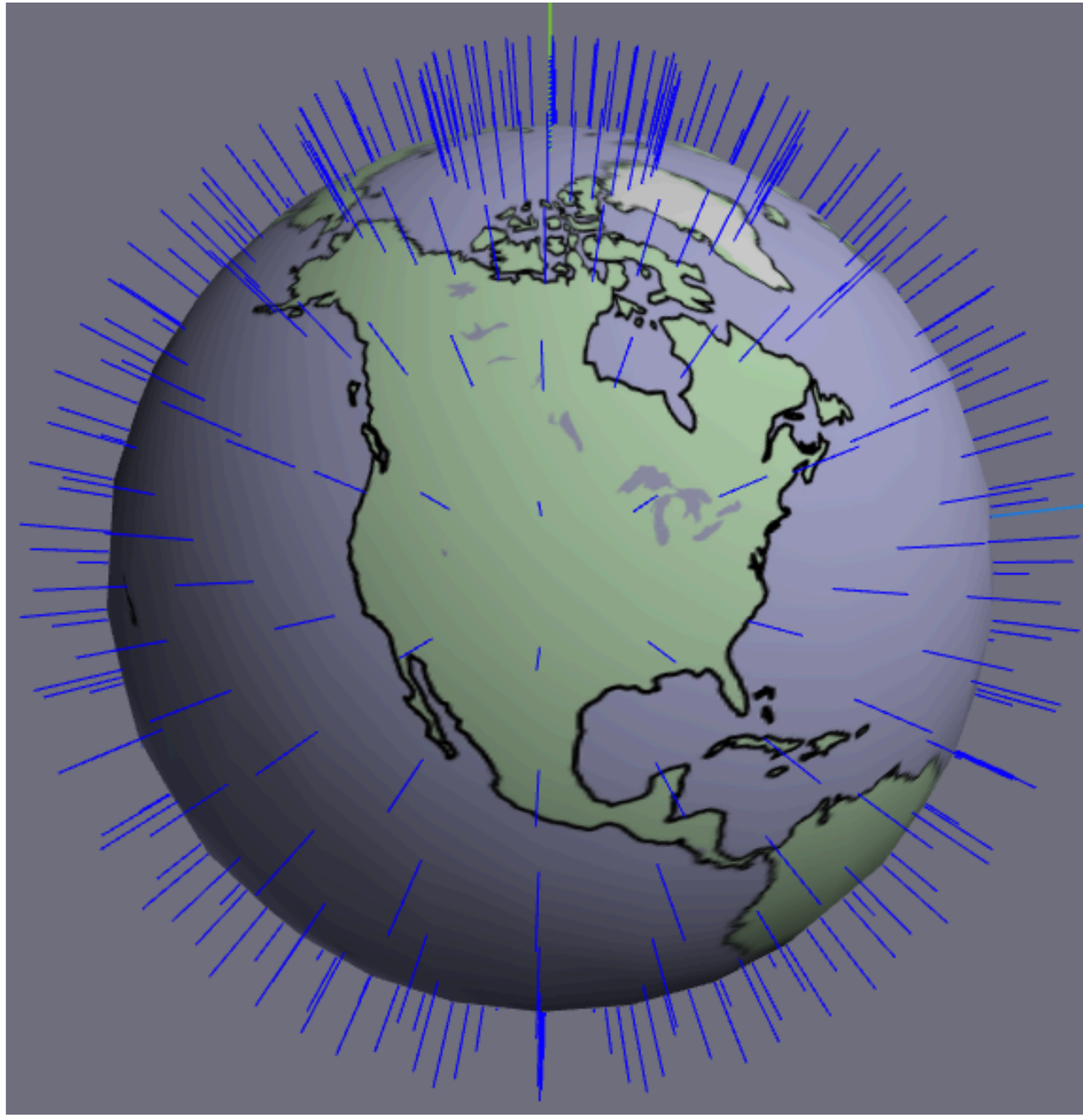
Computer Graphics



Lecture 4

Triangle Meshes: Texture Coordinates

Announcements

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- Slides, notes, demo files, etc are posted on the course webpage.

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- A1 - how's it going?

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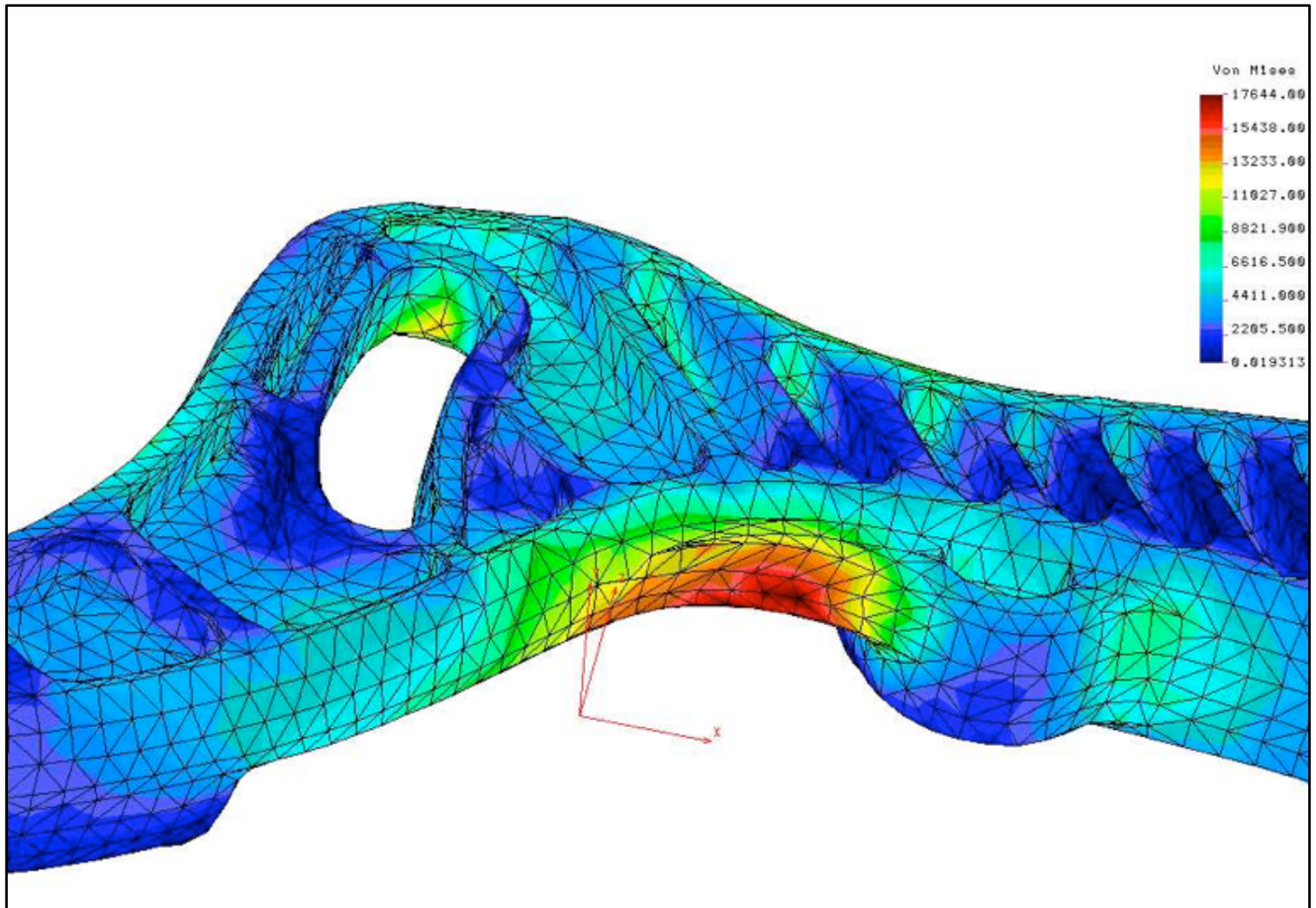
- A1 - how's it going?

- Office hours 12-1 today to replace yesterday's.

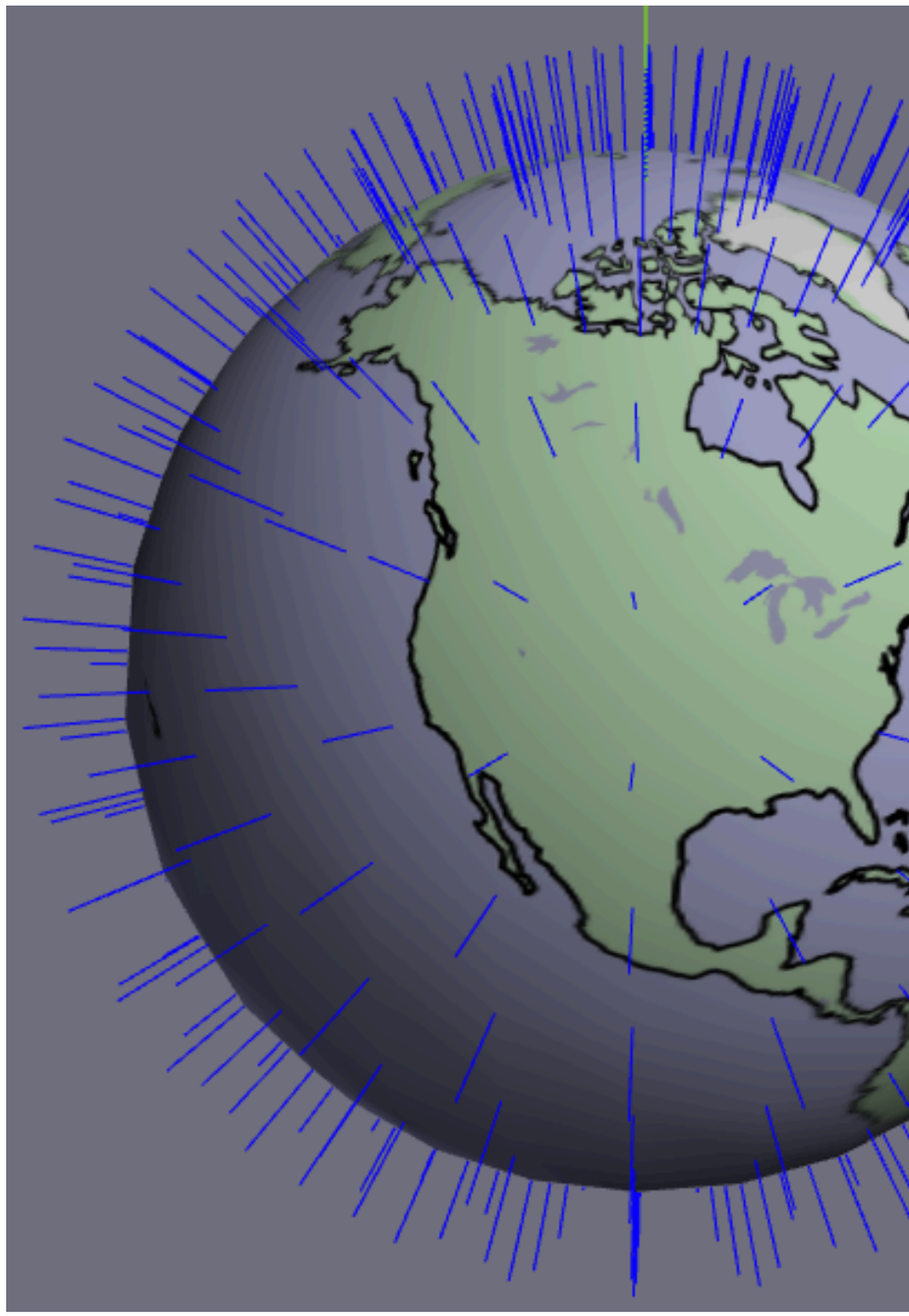
Last time: data on Meshes

- Often we need more than just geometry.
- Many properties vary continuously over a smooth surface.



Data on Meshes

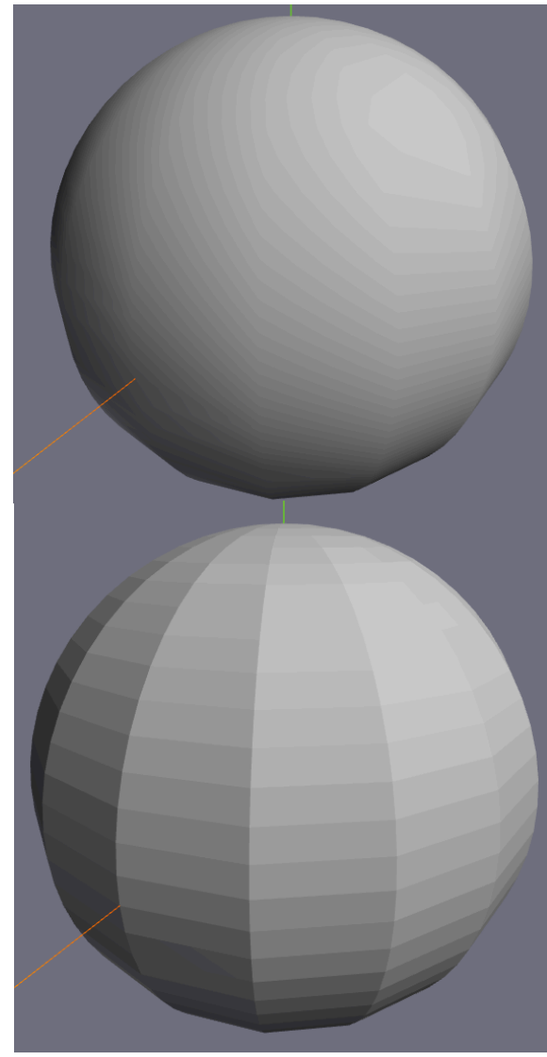
- What do we need to store at vertices?
  - **Positions**
    just another piece of per-vertex data
  - **Surface Normals** (last time)
    to more accurately portray geometry
  - **Texture Coordinates** (today)
    to paste image data onto surfaces

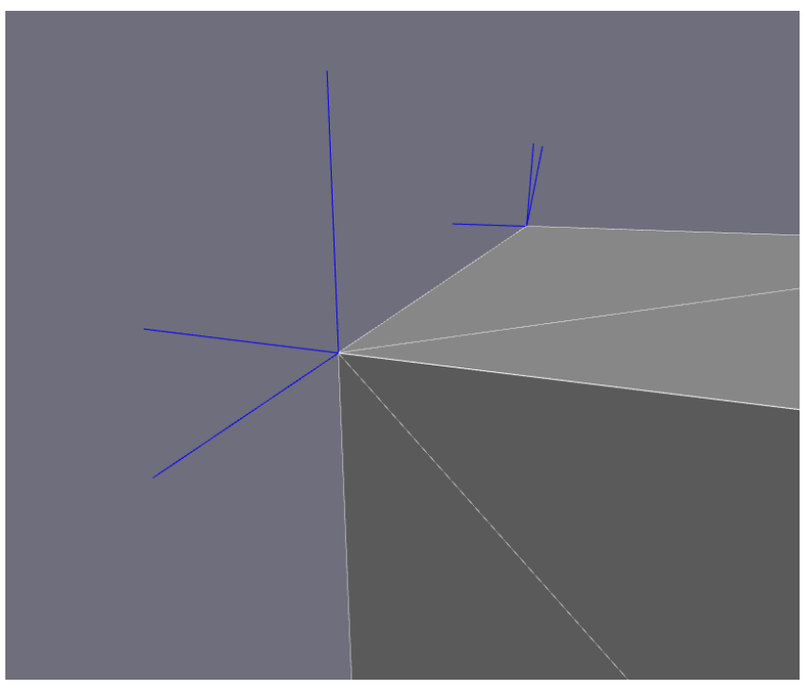


Surface Normals

- Most frequently we store data at vertices

- Last time: surface normals
  - allow for more accurate lighting of smooth geometry
  - smooth vs faceted: normal at a location depends on the triangle in question

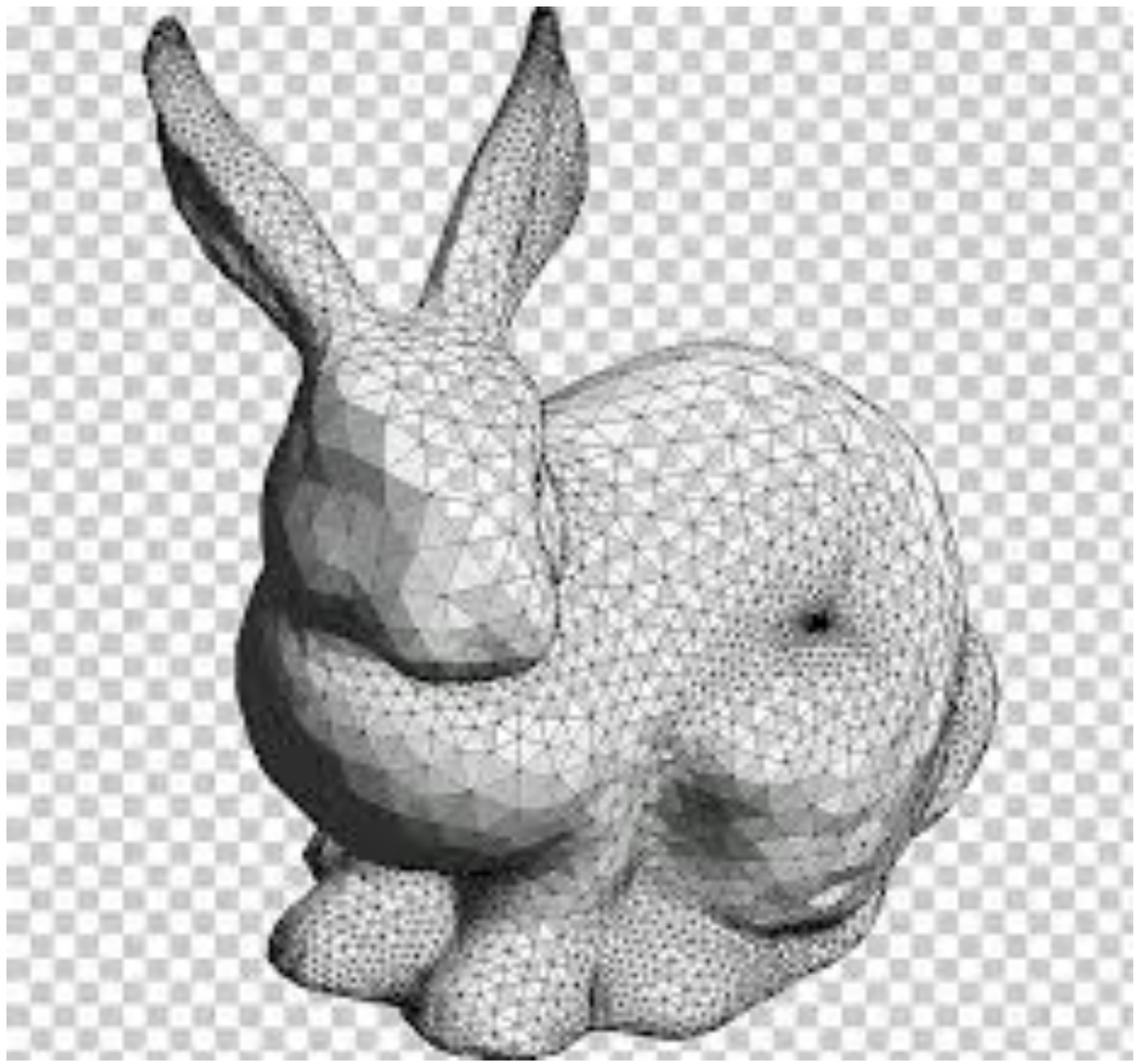




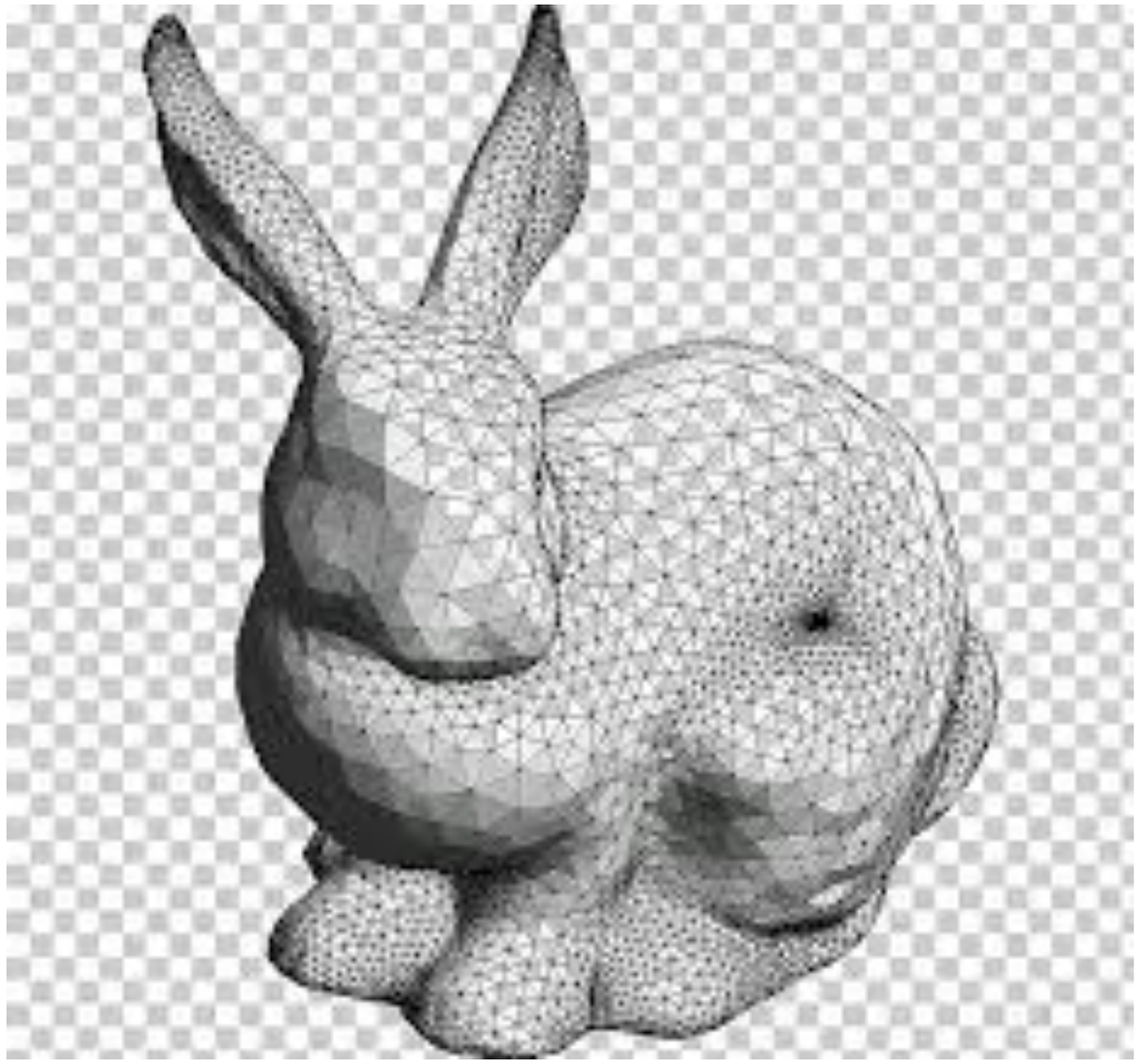
Estimating Surface Normals

- In shapes like a sphere and a cube, the normal is easy to calculate.

- What if the "true" surface isn't known?

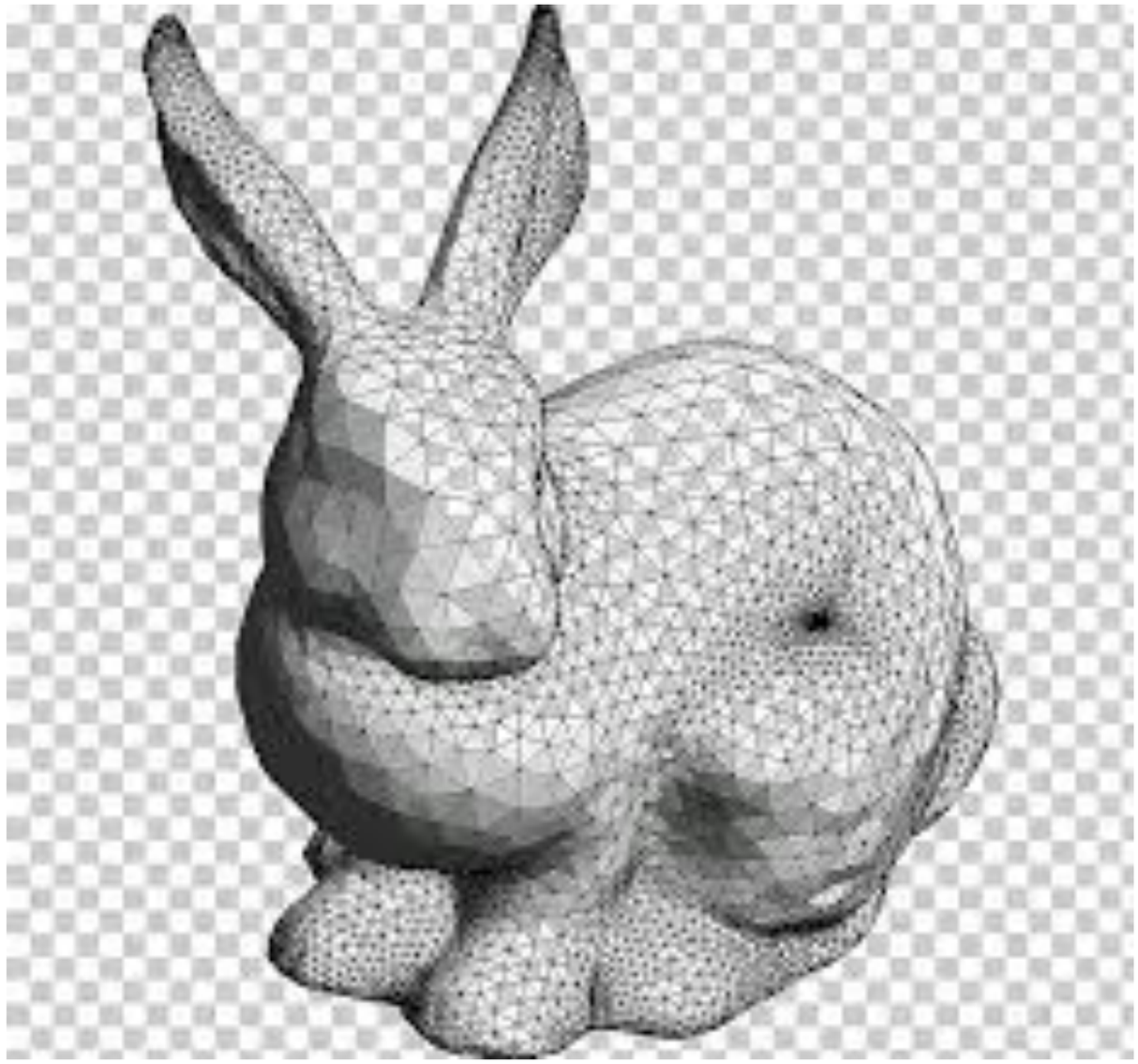


Estimating Surface Normals



Estimating Surface Normals

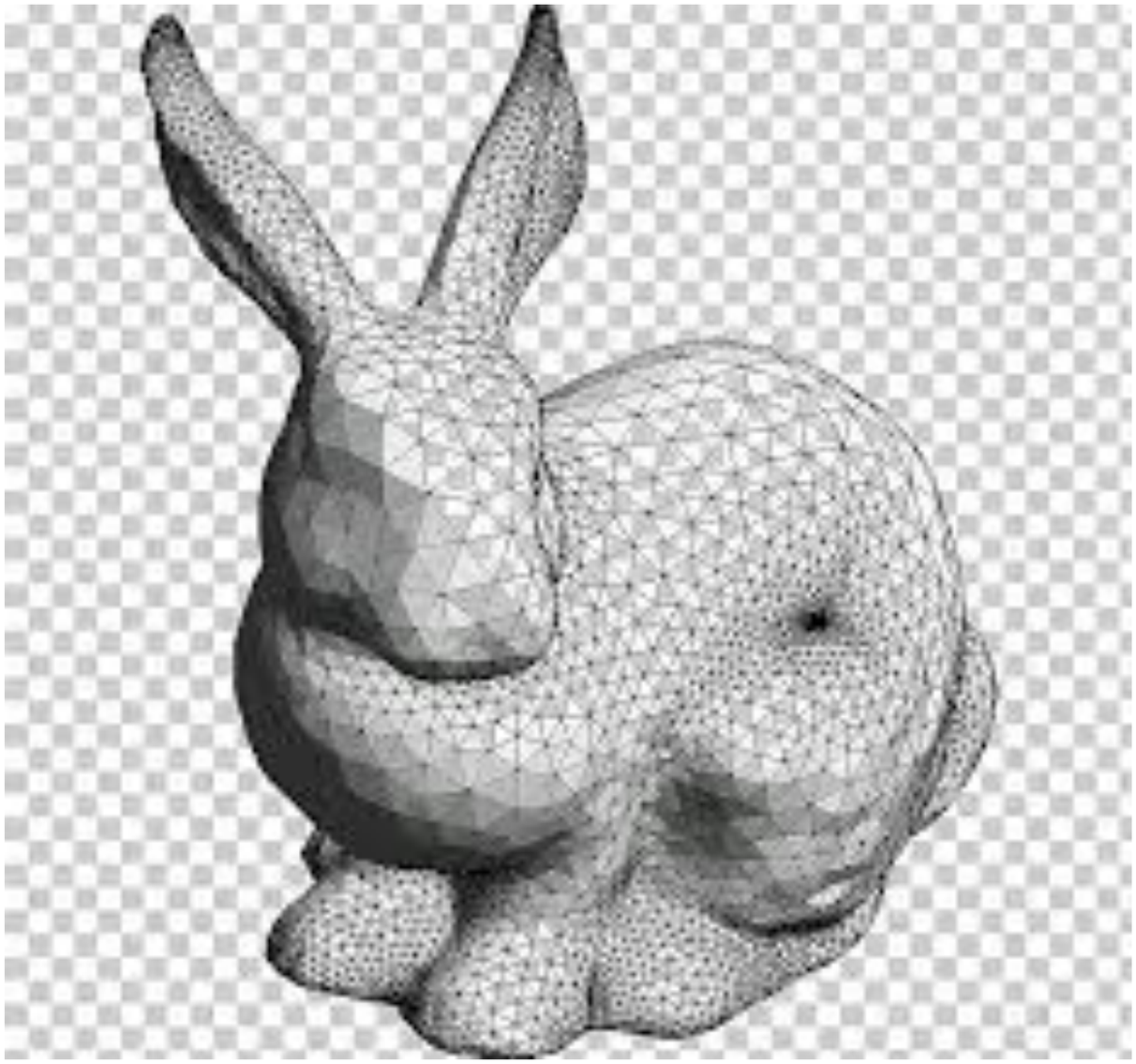
Faceted Objects



Estimating Surface Normals

Faceted Objects

Triangles represent geometry exactly.



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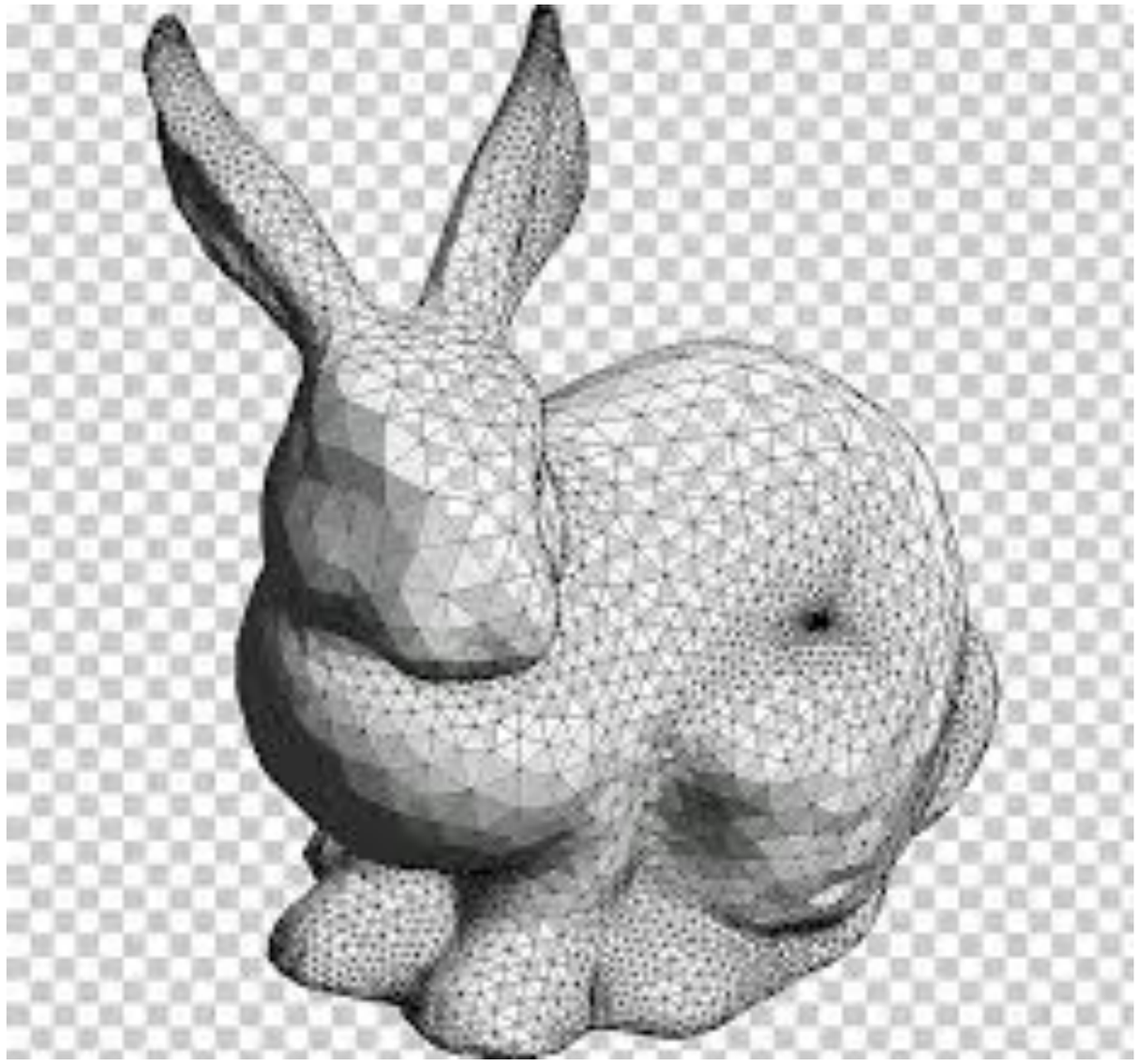
Triangles represent geometry exactly.

Like the cube, all normals are normal to their triangles.



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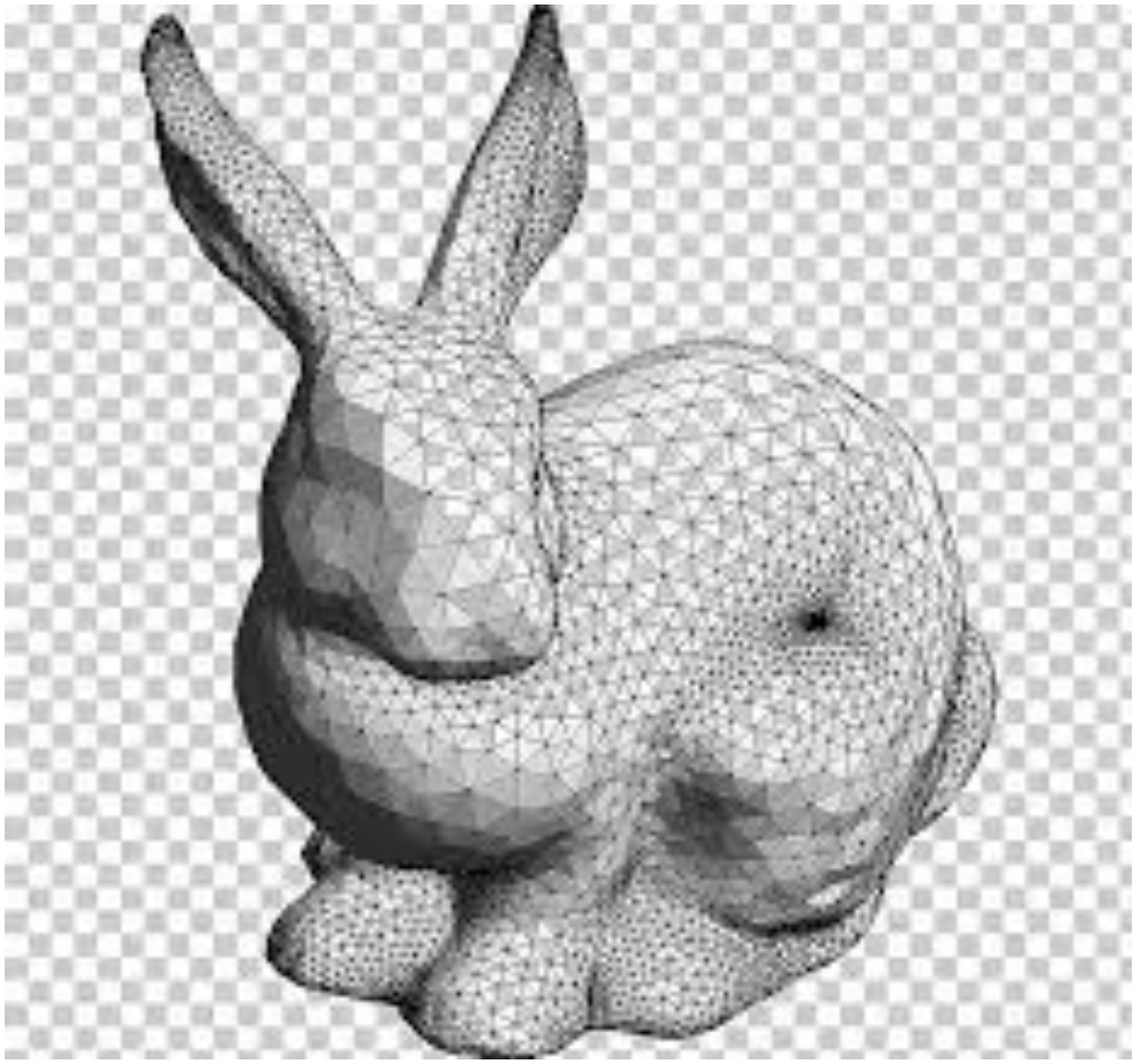
Smooth Objects



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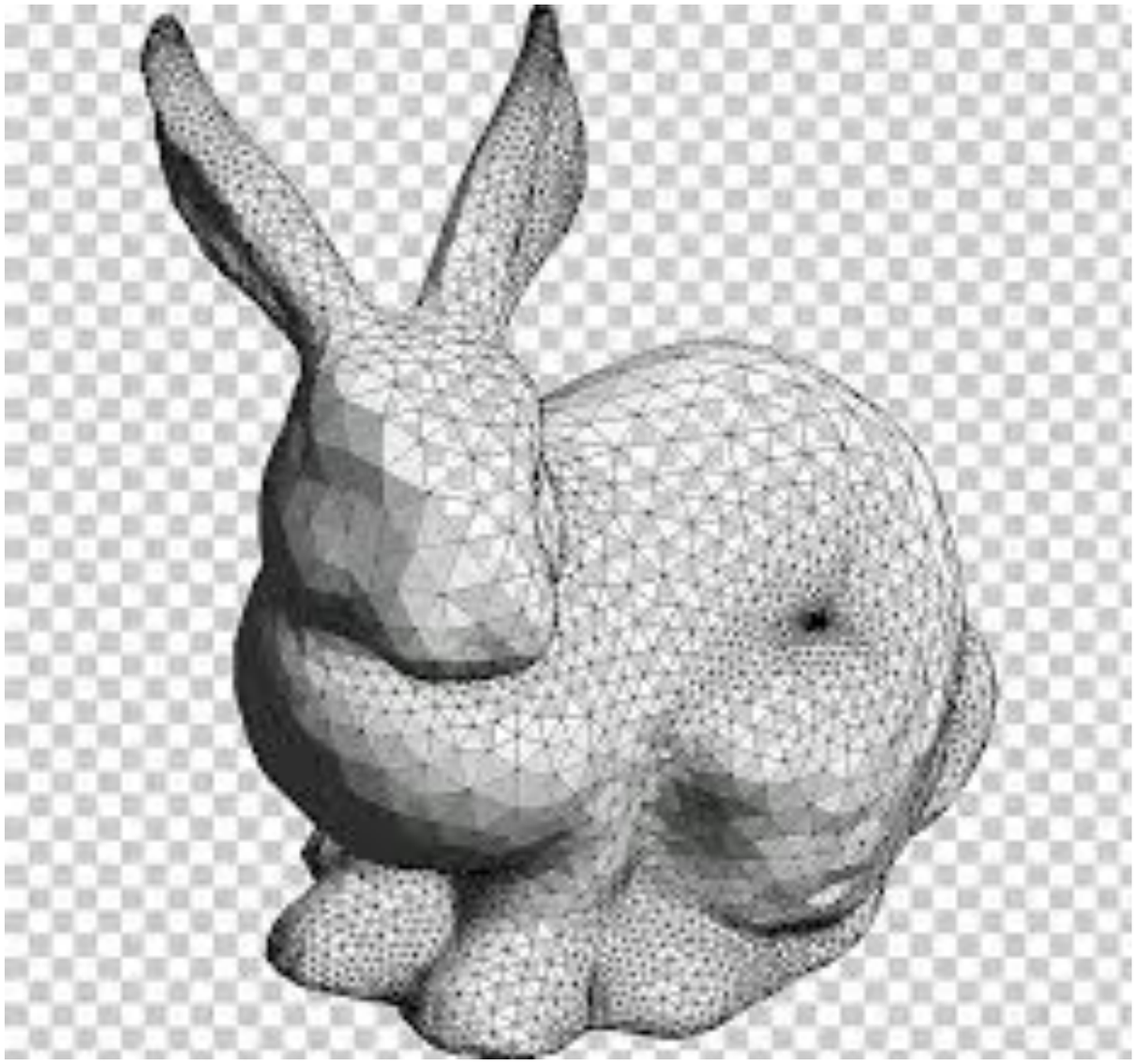
Smooth Objects

Triangles approximate smooth geometry.



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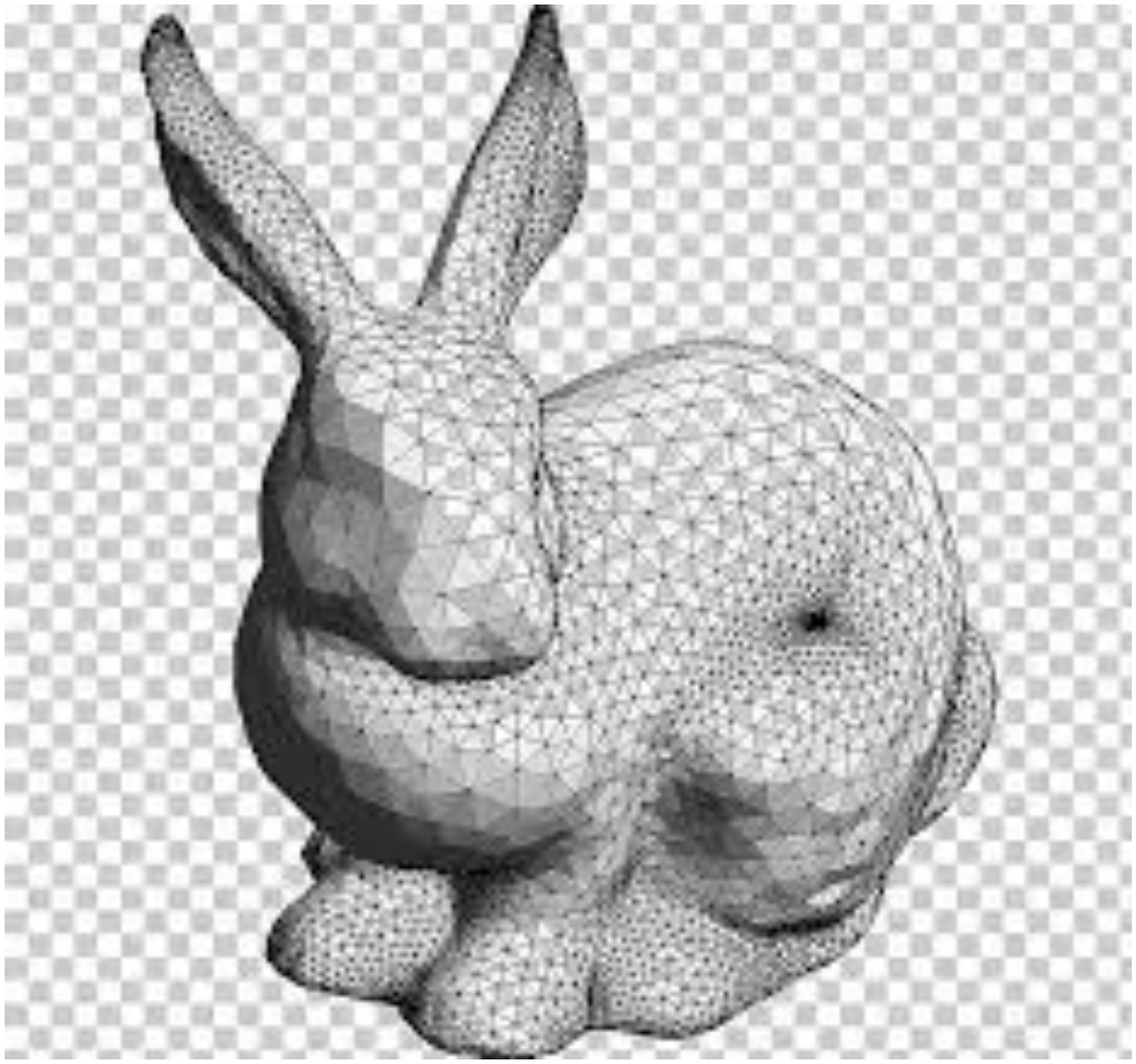
Vertex normal is the average of all surrounding triangle normals.



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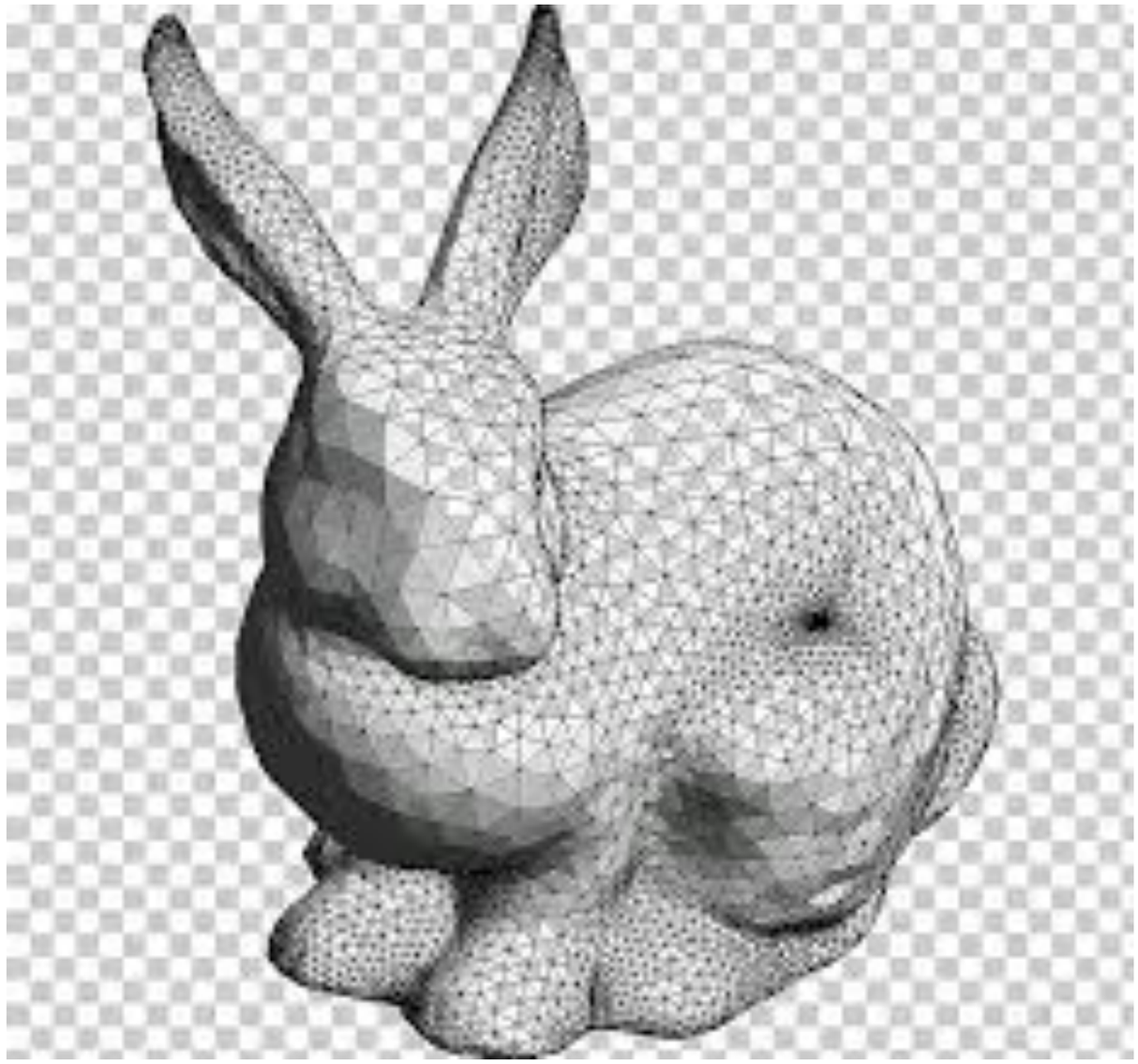

← This is the last part of A1.

Finding a vector normal to a triangle

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Finding a vector normal to a triangle

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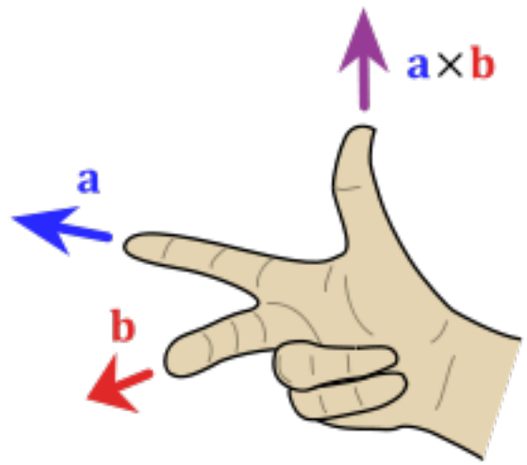
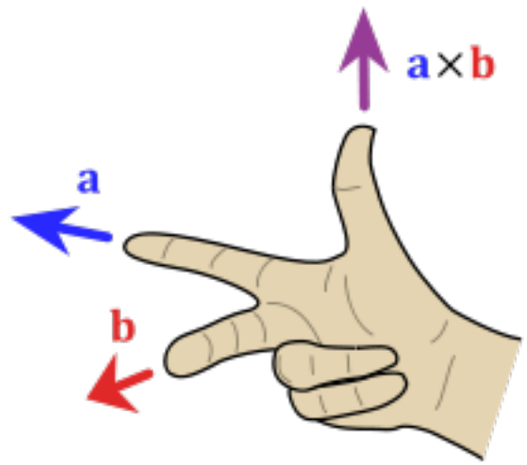
  - Hint 2: right-handed coordinate system



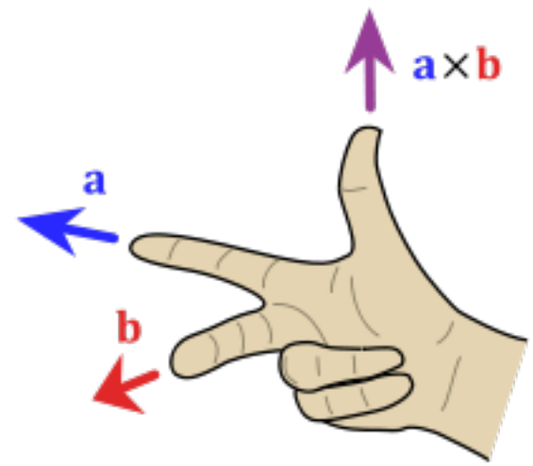
Finding a vector normal to a triangle

- What is a vector orthogonal to triangle (a, b, c)?
  - Hint 1: cross product
  - Hint 2: right-handed coordinate system
  - Hint 3: normal vectors are usually kept unit length



Finding a vector normal to a triangle

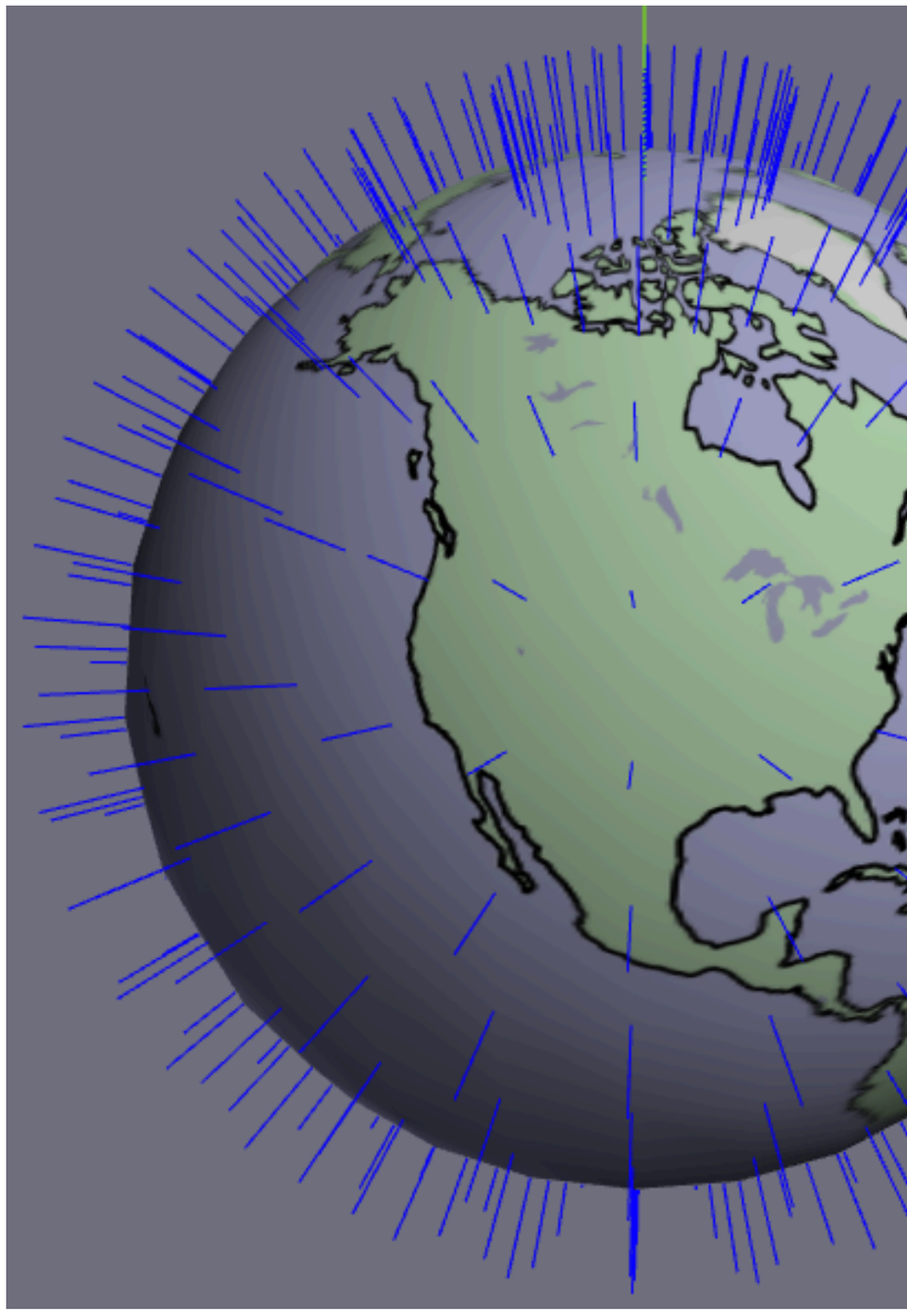
- What is a vector orthogonal to triangle (a, b, c)?
  - Hint 1: cross product
  - Hint 2: right-handed coordinate system
  - Hint 3: normal vectors are usually kept unit length
  - Hint 4 (for posterity): Section 2.7.2 in the book.



Questions?

Data on Meshes

- What do we need to store at vertices?
  - **Surface Normals**
    to more accurately portray geometry
  - **Texture Coordinates**
    to paste image data onto surfaces
  - **Positions!?** (last lecture)
    just another piece of per-vertex data!



Textures

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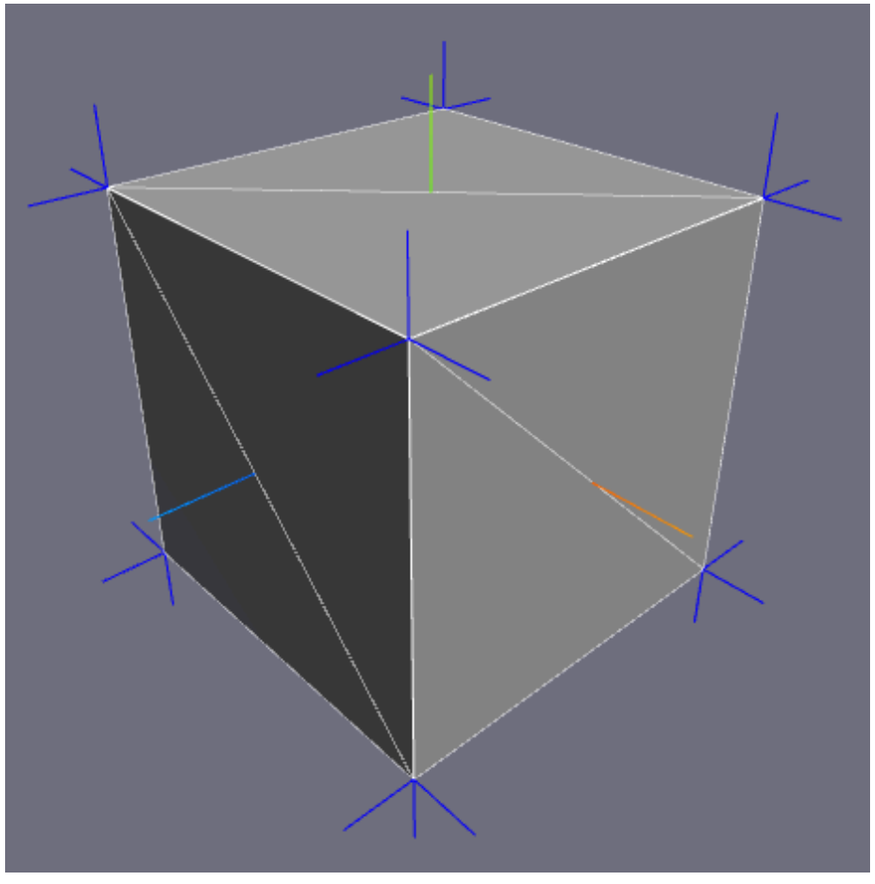

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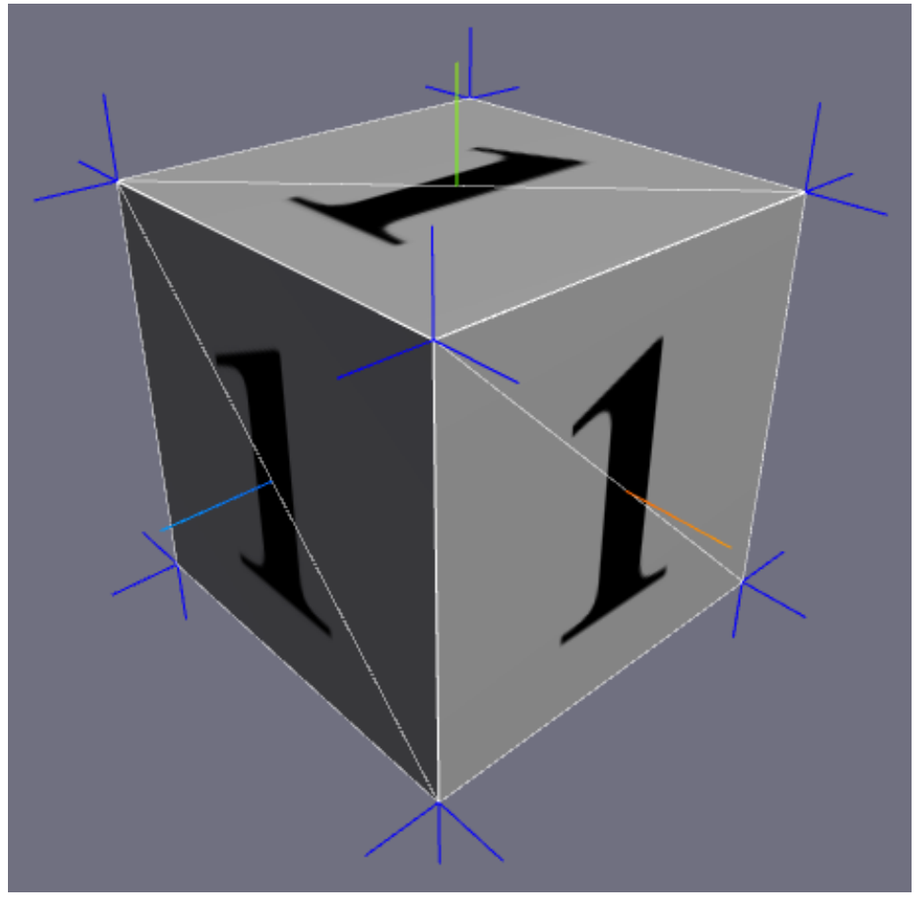

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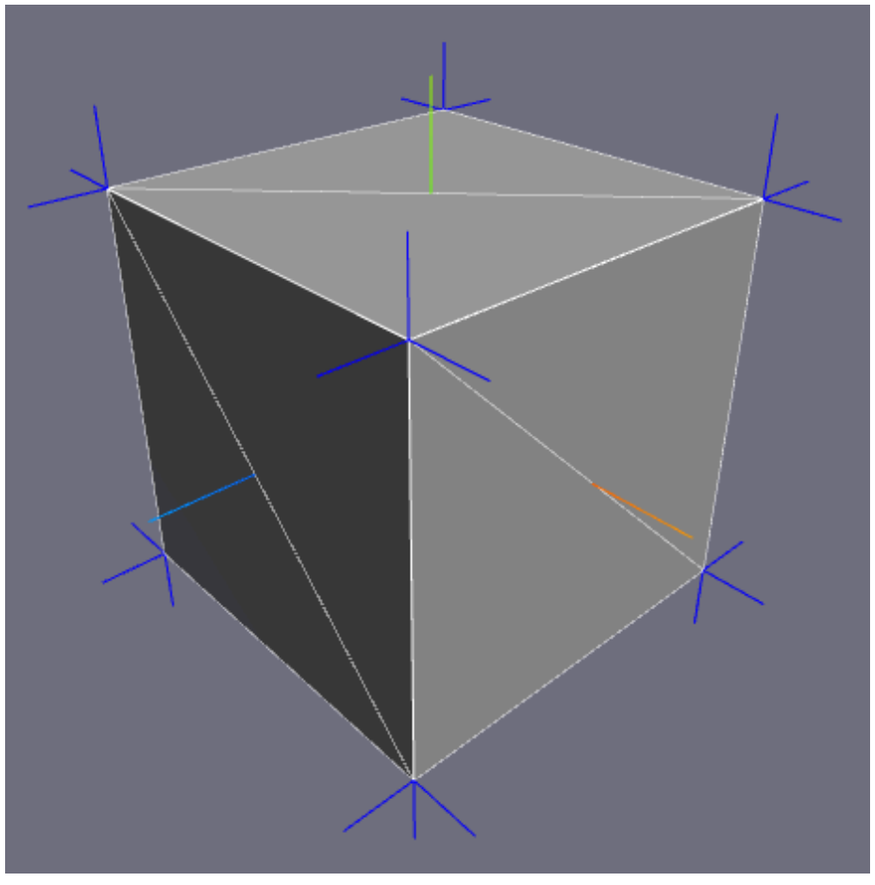

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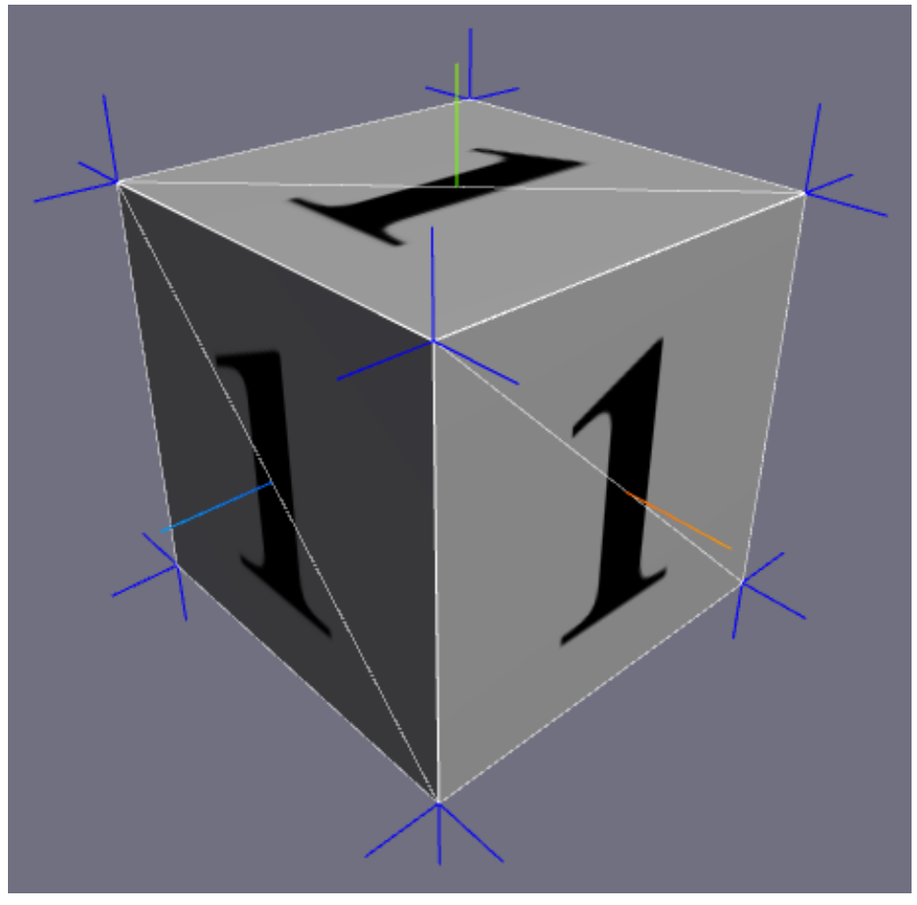

Using current machinery: store a color at each vertex and interpolate between them.

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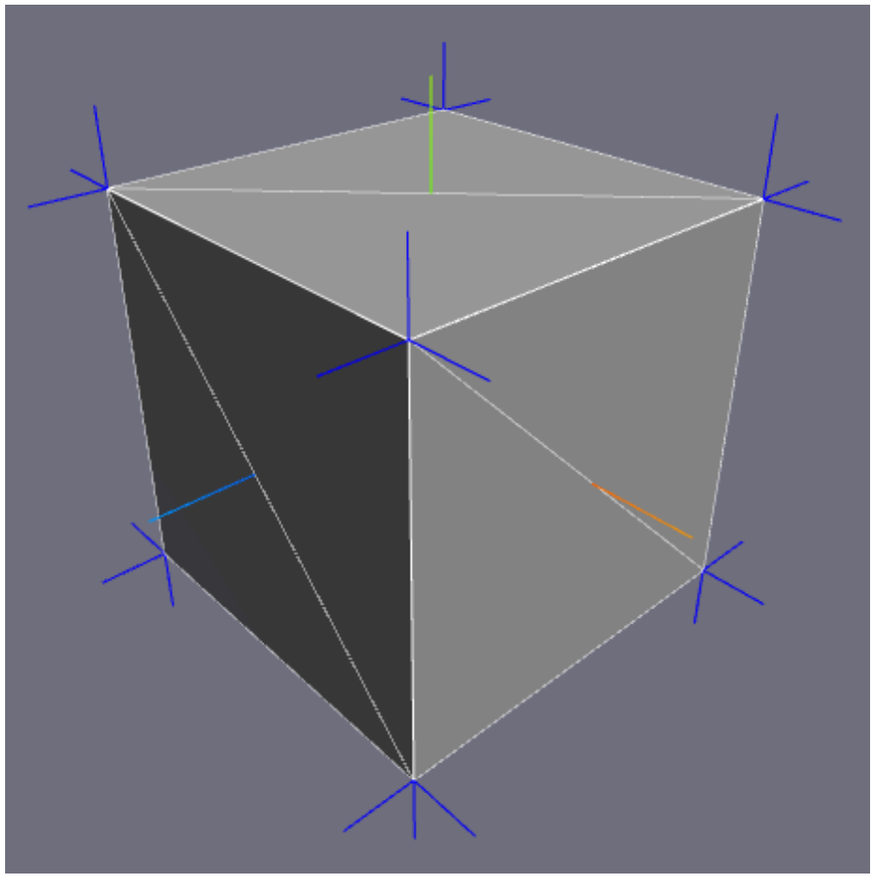

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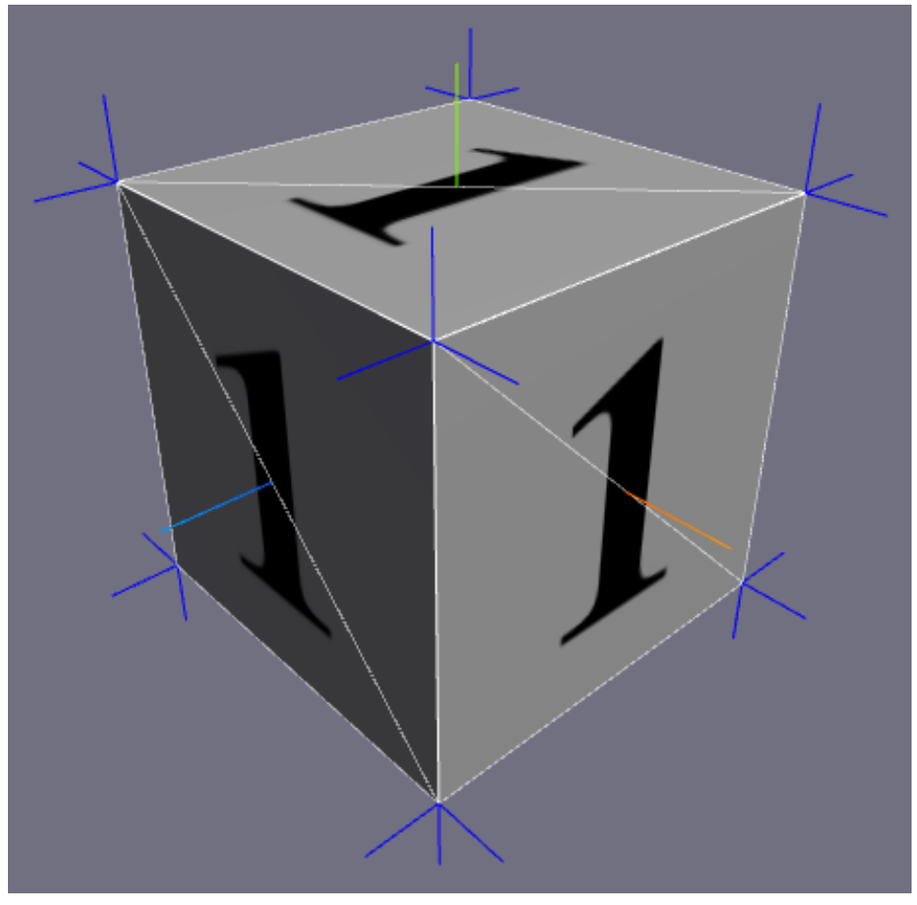

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We'd need a bunch more triangles.

Textures

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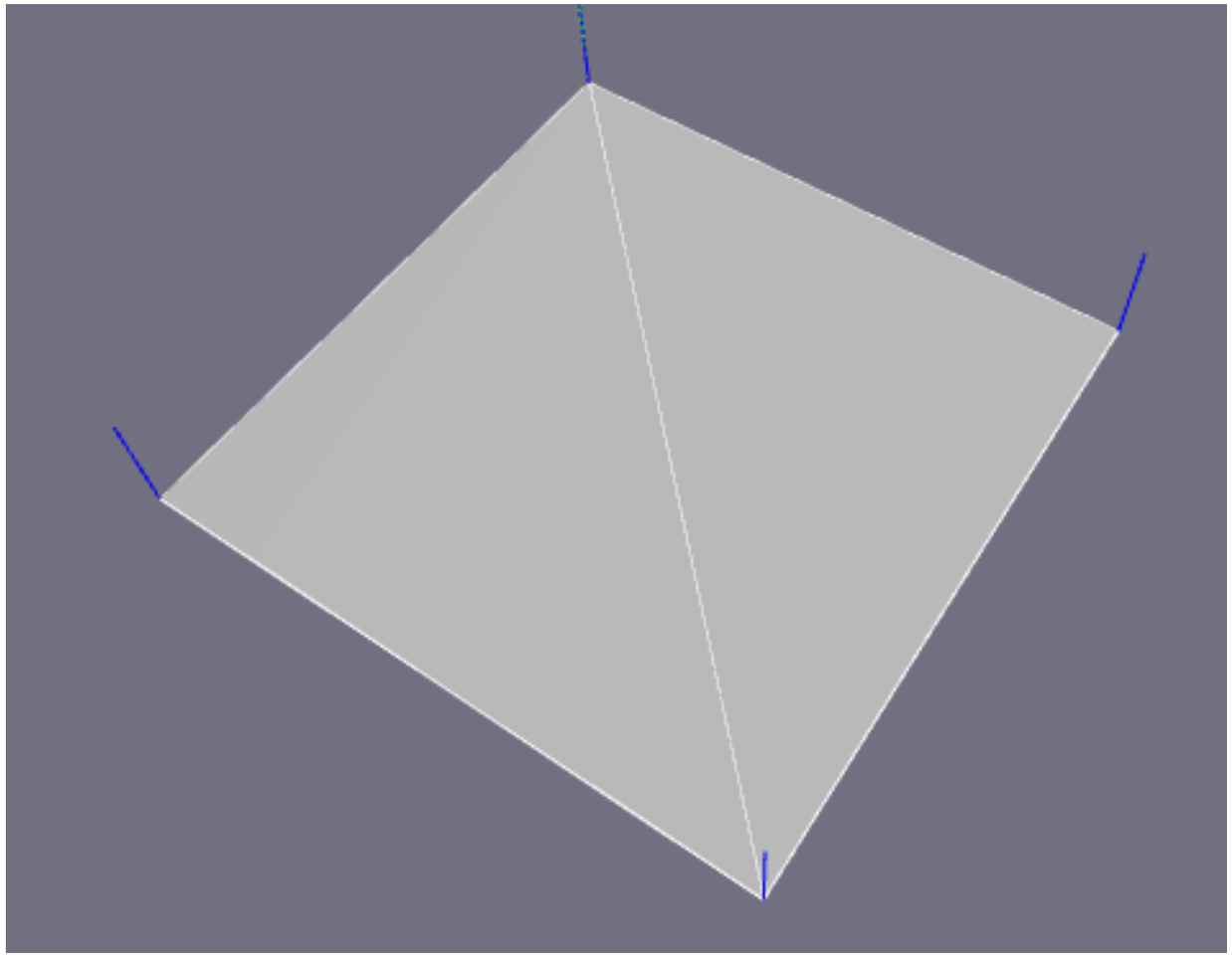

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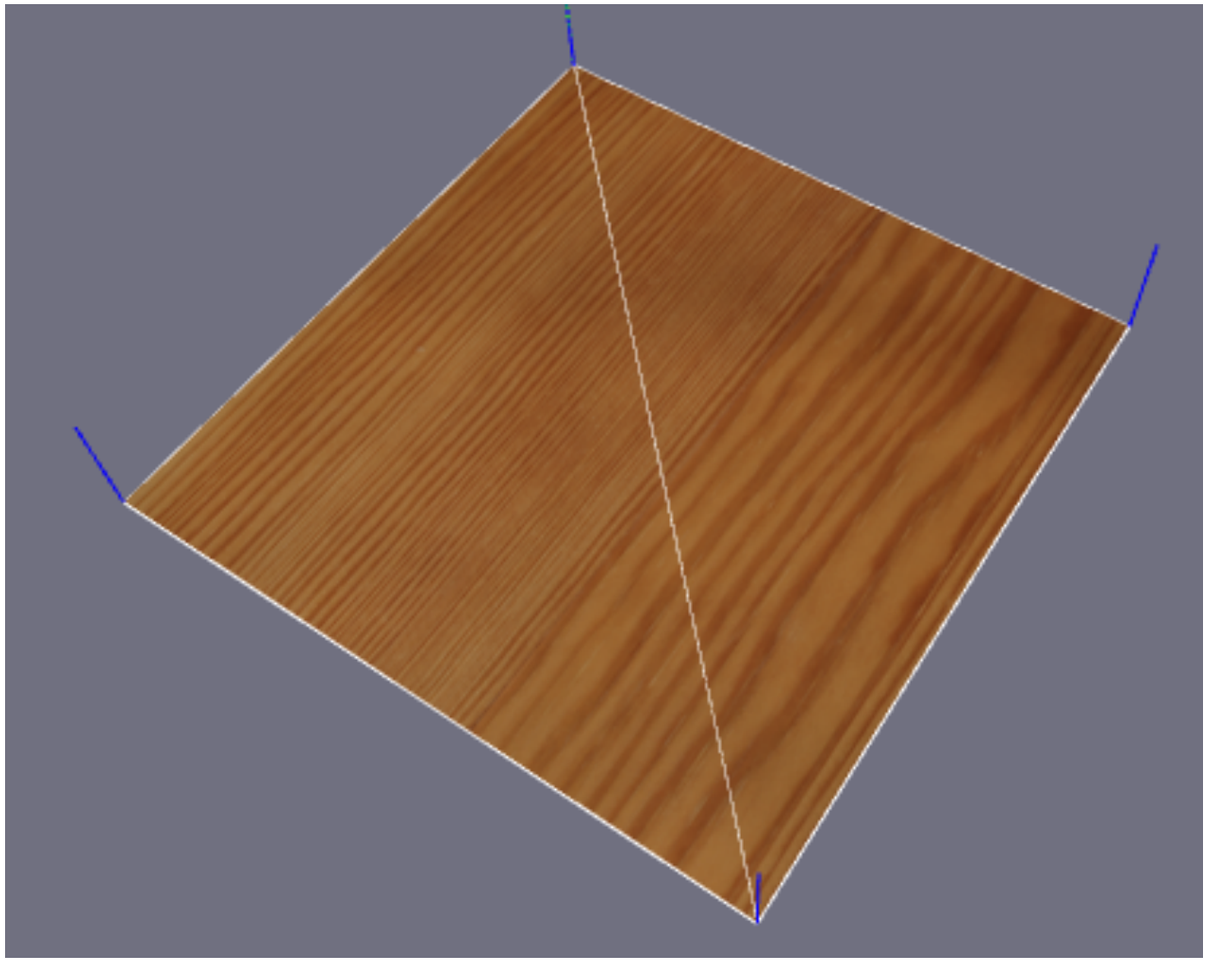

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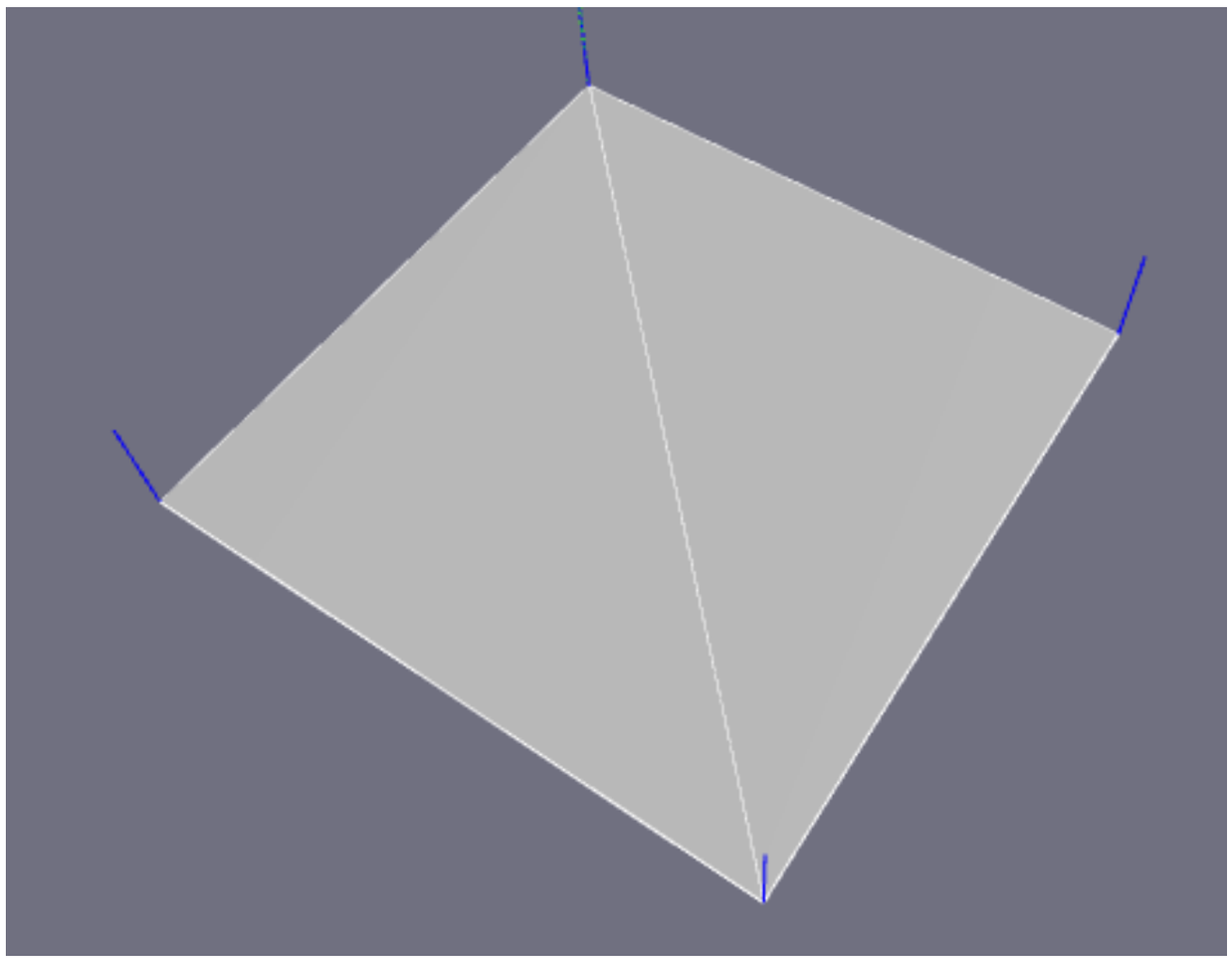

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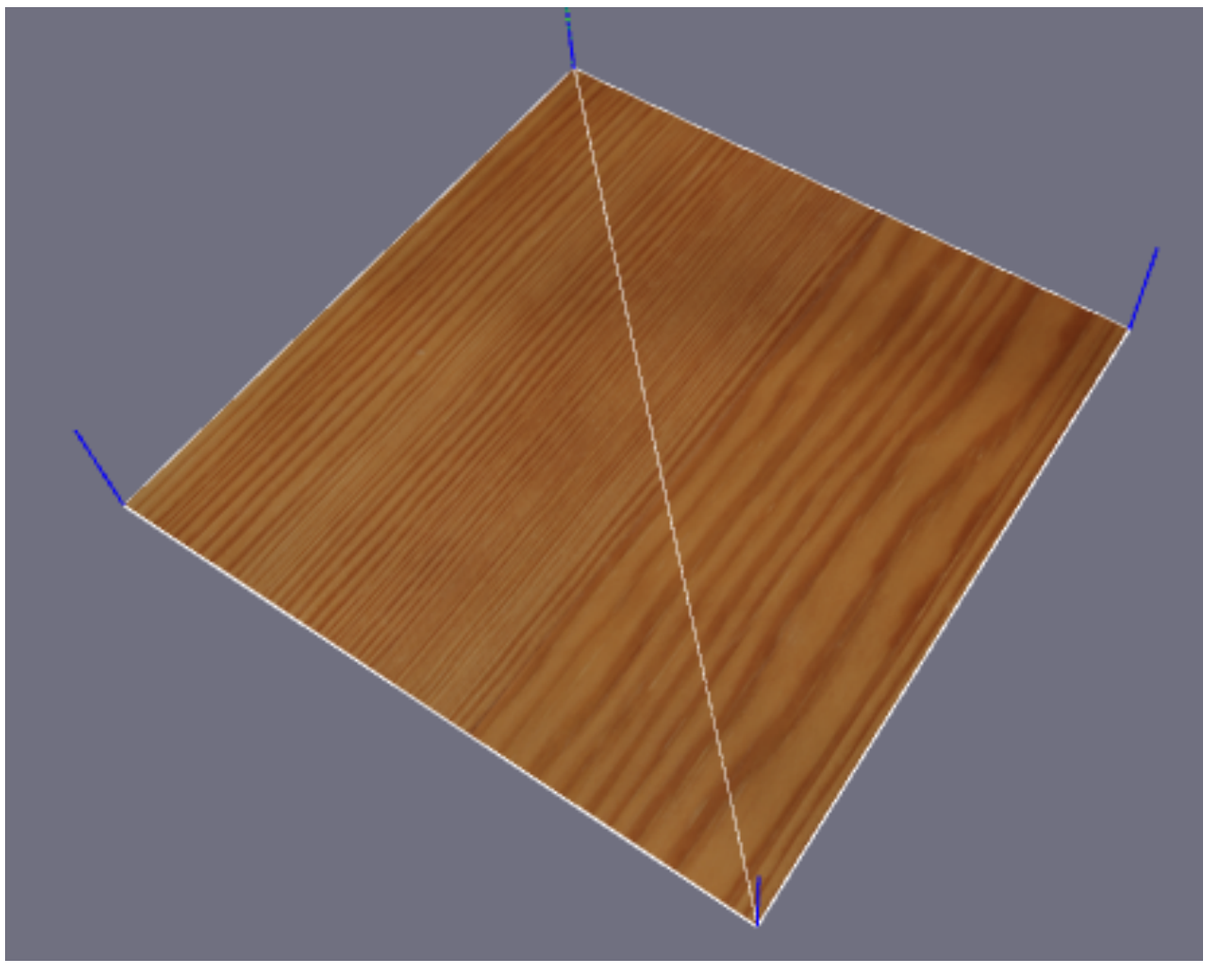


We'd need a **bunch** more triangles.

Textures

- Store **spatially varying surface properties:**
  - color is an intuitive example, but many other things too; anything that changes over the surface but doesn't affect geometry (much)
  - roughness, faked lighting effects, normals(!?), bumps

What is a texture?

- A texture is basically a 2D image that stores some **spatially-varying surface property**.

  (use color for intuition, but keep in mind it's more general)

2D grid of values ("texels")
u, v coordinates in [0, 1]

Texture Mapping

- To use this, we need a **mapping** (function)
  - from the surface we're modeling/rendering
  - to (u,v) **texture coordinates**

- **Simplest possible example:**
  a 2x2 tabletop in the xz plane

- When rendering, non-vertex points get colors via **interpolated** (u,v) coordinates.

Texture Mapping: nontrivial surfaces

Rendering (later!)

Texture mapping

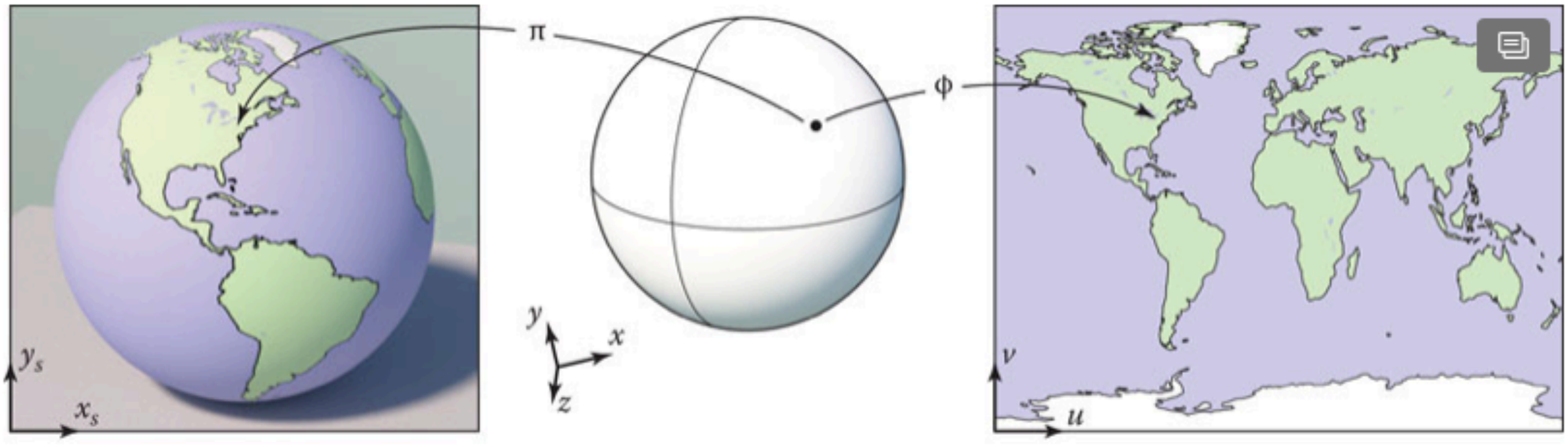


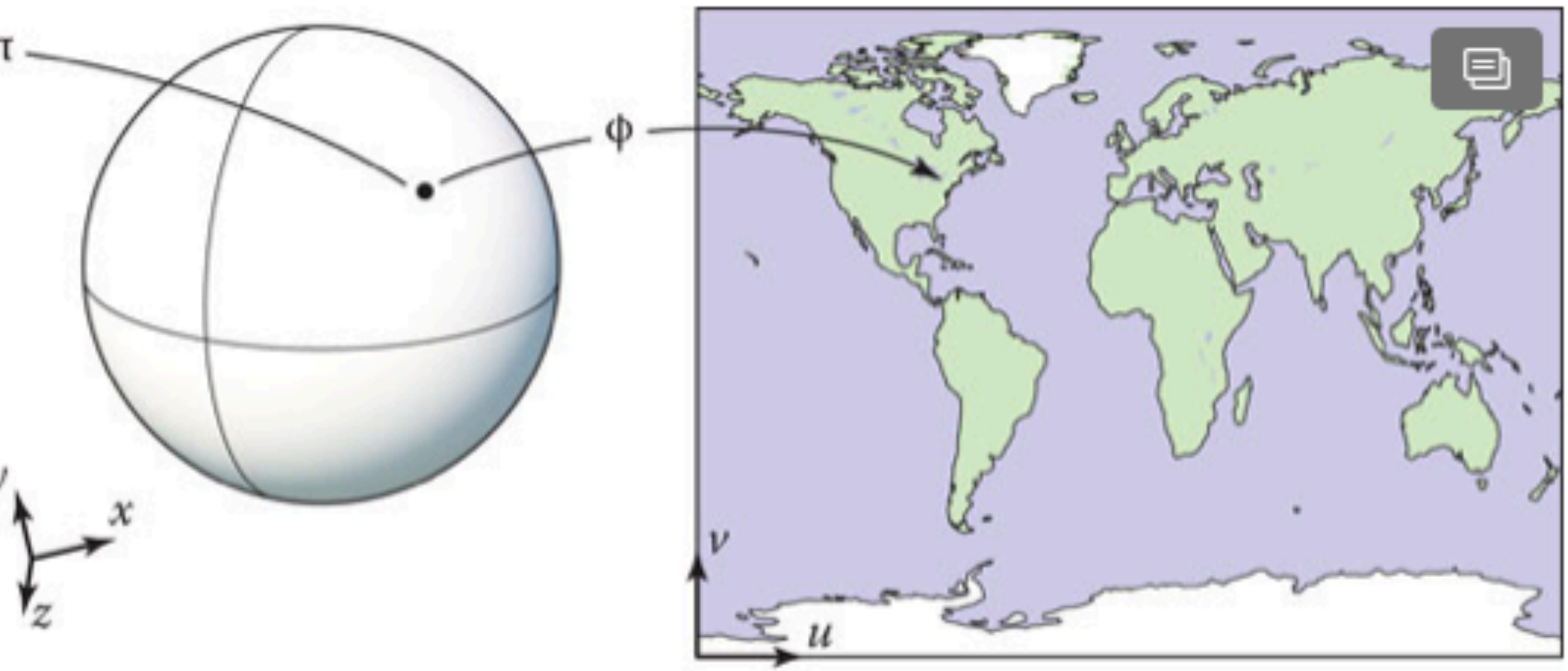
Image space

Surface *S* in world space

Texture space, *T*

Texture Mapping: nontrivial surfaces

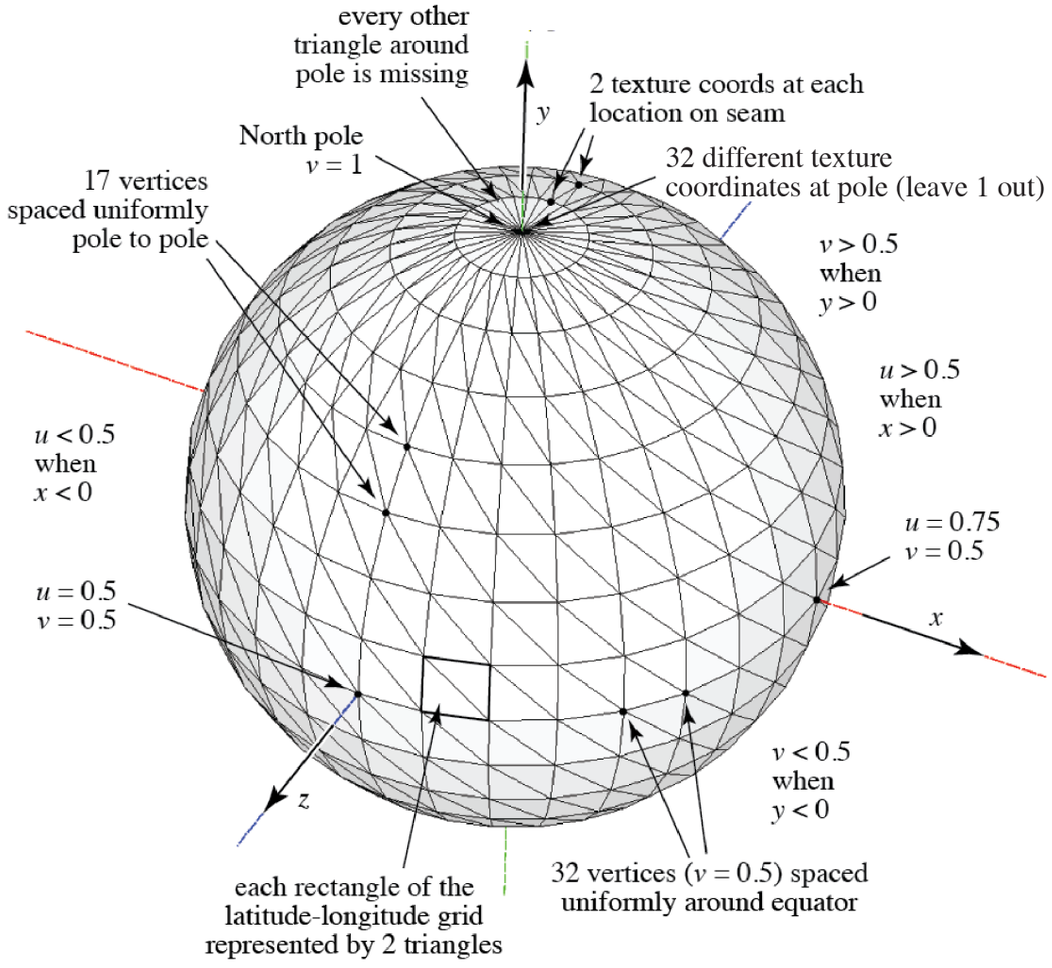
- Map from point on sphere to point in (u,v)

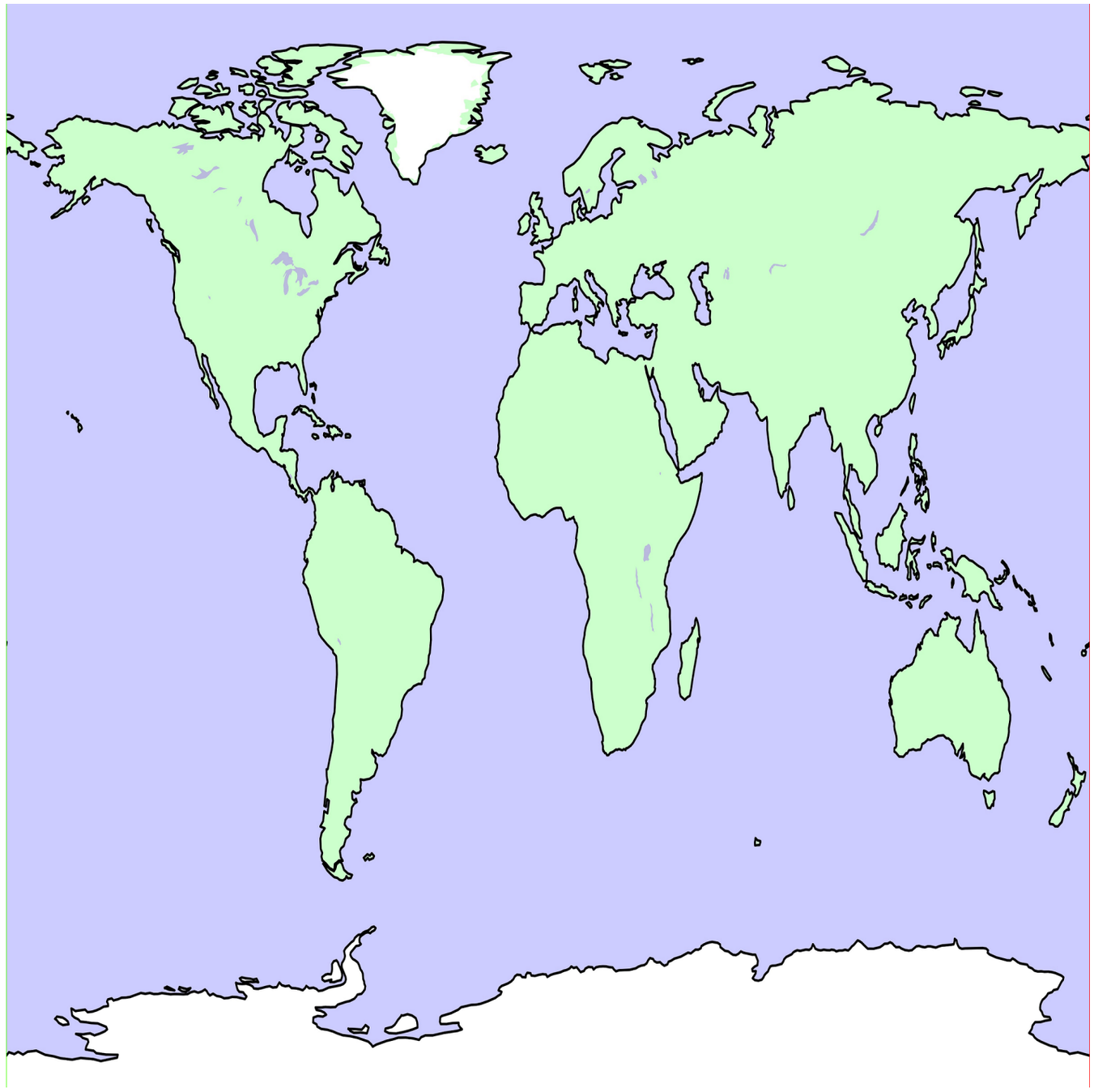


Surface *S* in world space

Texture space, *T*

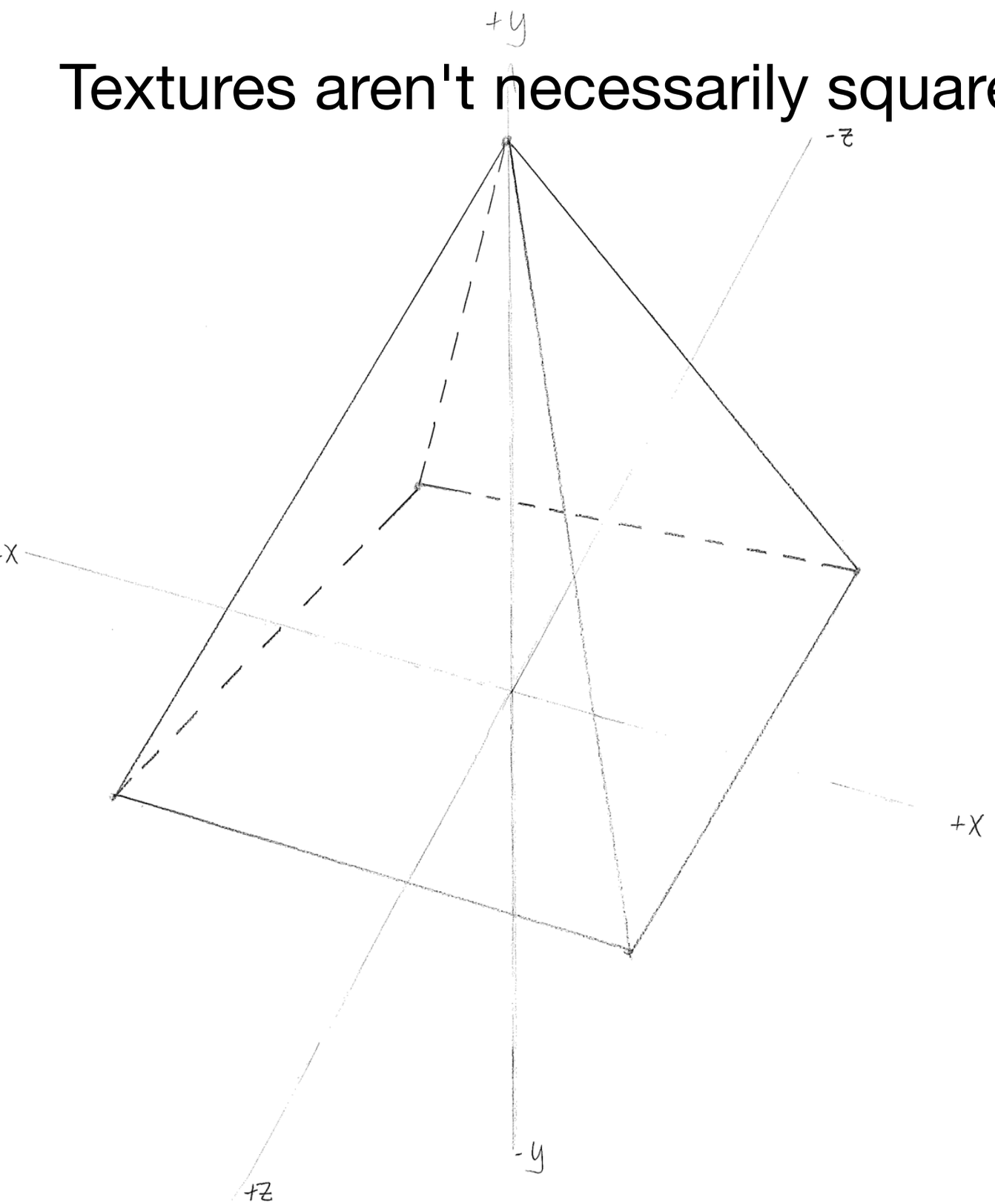
A1 sphere - demo

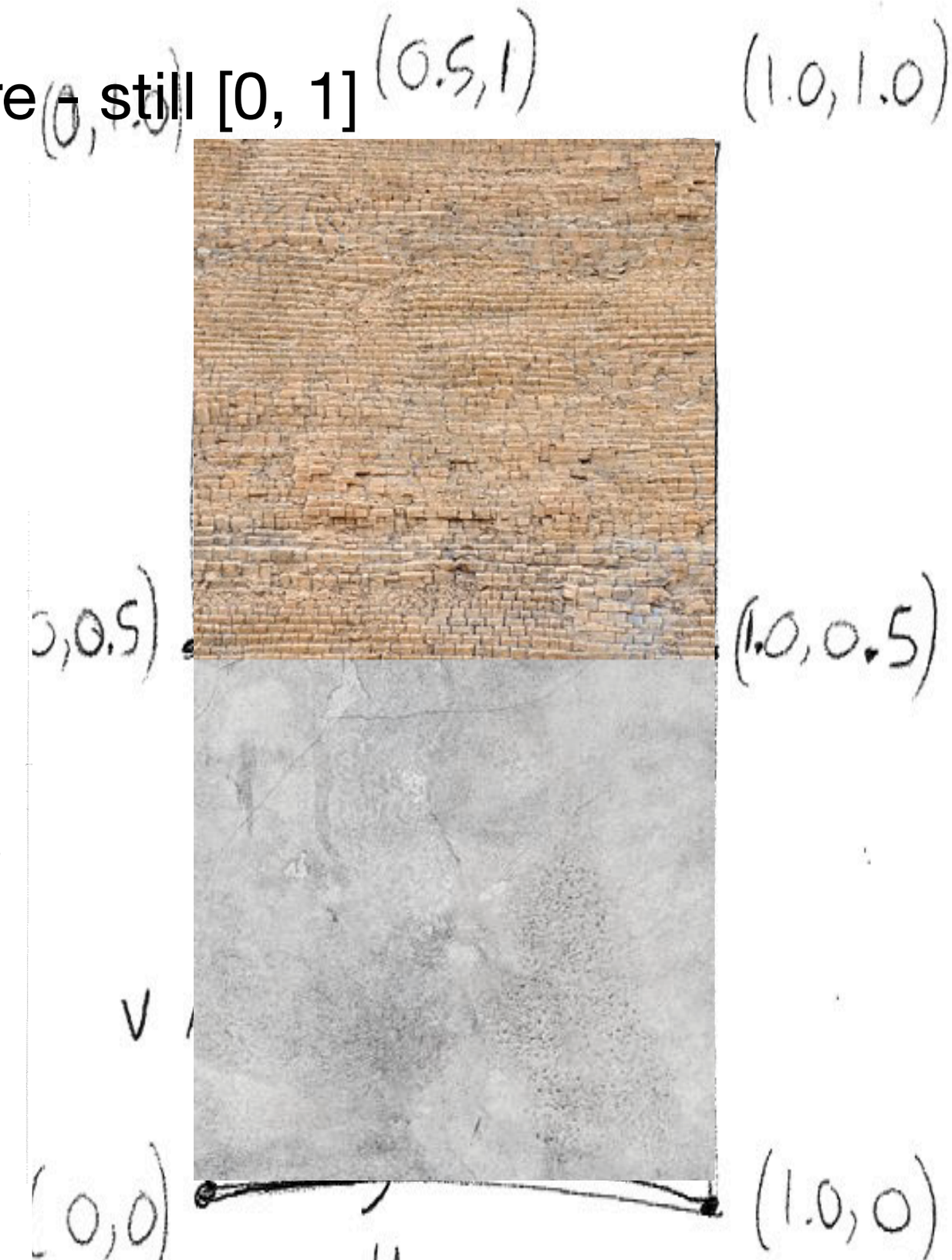




Texture Mapping the Pyramid

Textures aren't necessarily square - still [0, 1]





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