Polygonal Shading

Polygonal Shading

- Curved surfaces are approximated by polygons
- How do we shade?
  - Flat shading
  - Interpolative shading
  - Gouraud shading
  - Phong shading (different from Phong illumination)
- Two questions:
  - How do we determine normals at vertices?
  - How do we calculate shading at interior points?

Flat Shading

- Normal: given explicitly before vertex

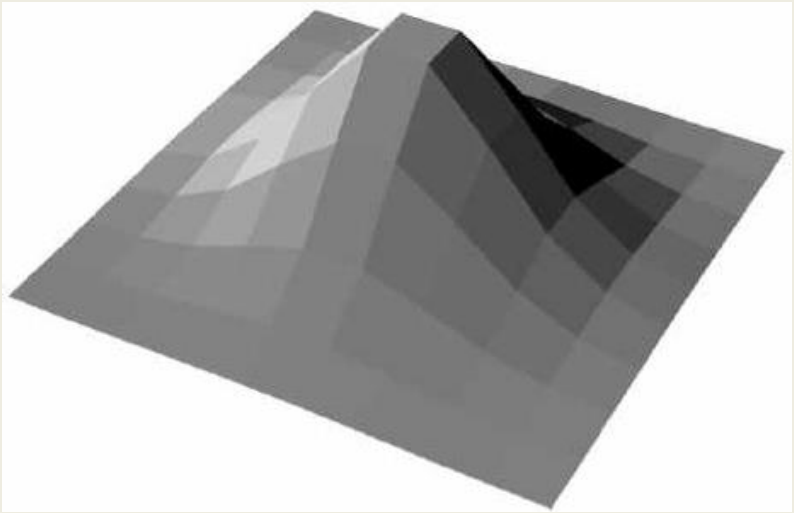
  glNormal3f(nx, ny, nz)

  glVertex3f(x, y, z)

- Shading constant across polygon
- Single polygon: first vertex

Flat Shading Assessment

- Inexpensive to compute
- Appropriate for objects with flat faces
- Less pleasant for smooth surfaces



Interpolative Shading

- Enable with

  glShadeModel(GL_SMOOTH)

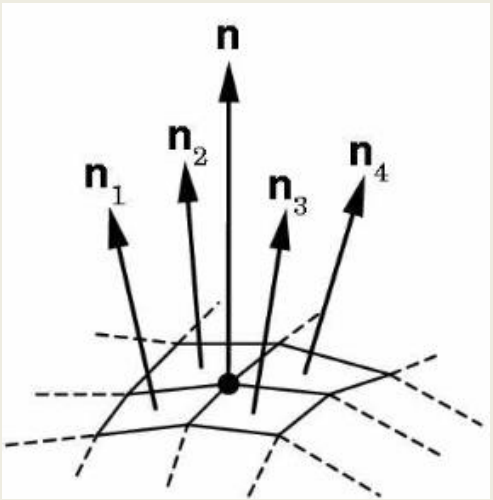
- Calculate color at each vertex
- Interpolate color in interior
- Compute during scan conversion (rasterization)
- More expensive to calculate

Gouraud Shading

- Special case of interpolative shading
- How do we calculate vertex normals?
- Gouraud: average all adjacent face normals

$$\mathbf{n} = \frac{\mathbf{n}_1 + \mathbf{n}_2 + \mathbf{n}_3 + \mathbf{n}_4}{|\mathbf{n}_1 + \mathbf{n}_2 + \mathbf{n}_3 + \mathbf{n}_4|}$$

- Requires knowledge about which faces share a vertex



Data Structures for Gouraud Shading

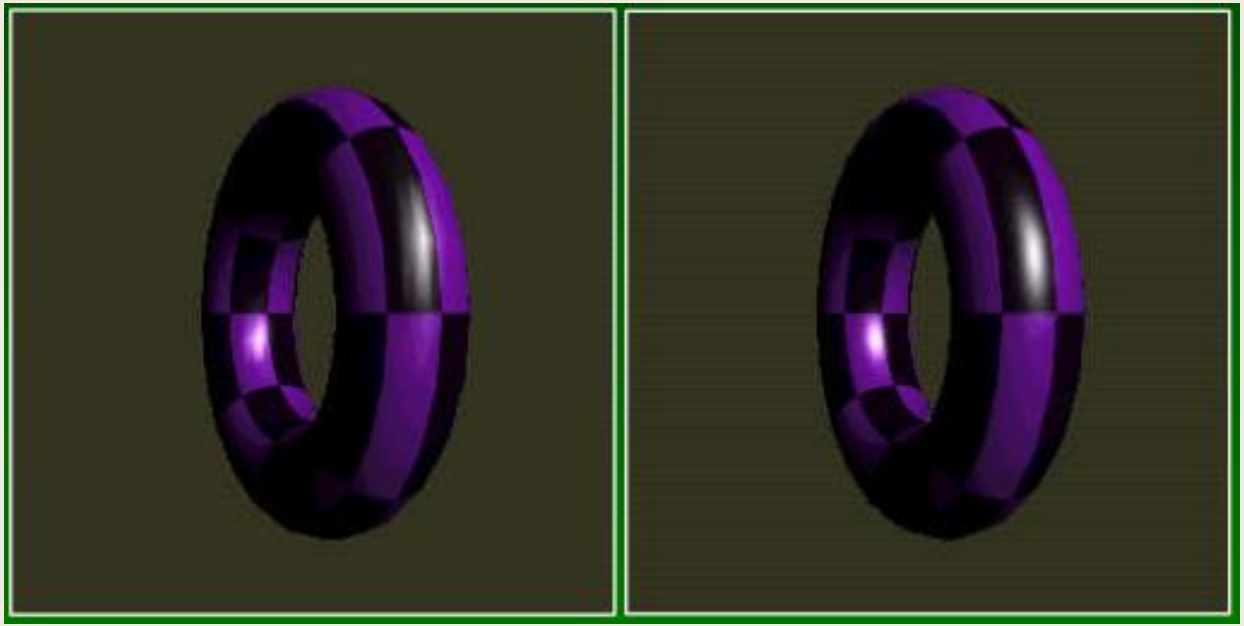
- Sometimes vertex normals can be computed directly (e.g. height field with uniform mesh)
- More generally, need data structure for mesh
- Key: which polygons meet at each vertex

Phong Shading

- Interpolate normals rather than colors
- Significantly more expensive
- Mostly done off-line (not supported in OpenGL)

Phong Shading Results

Michael Gold, Nvidia



Phong Lighting
Gouraud Shading

Phong Lighting
Phong Shading

Polygonal Shading Summary

- Gouraud shading
  - Set vertex normals
  - Calculate colors at vertices
  - Interpolate colors across polygon
- Must calculate vertex normals!
- Must normalize vertex normals to unit length!