10 – surface shading

Illumination and Shading

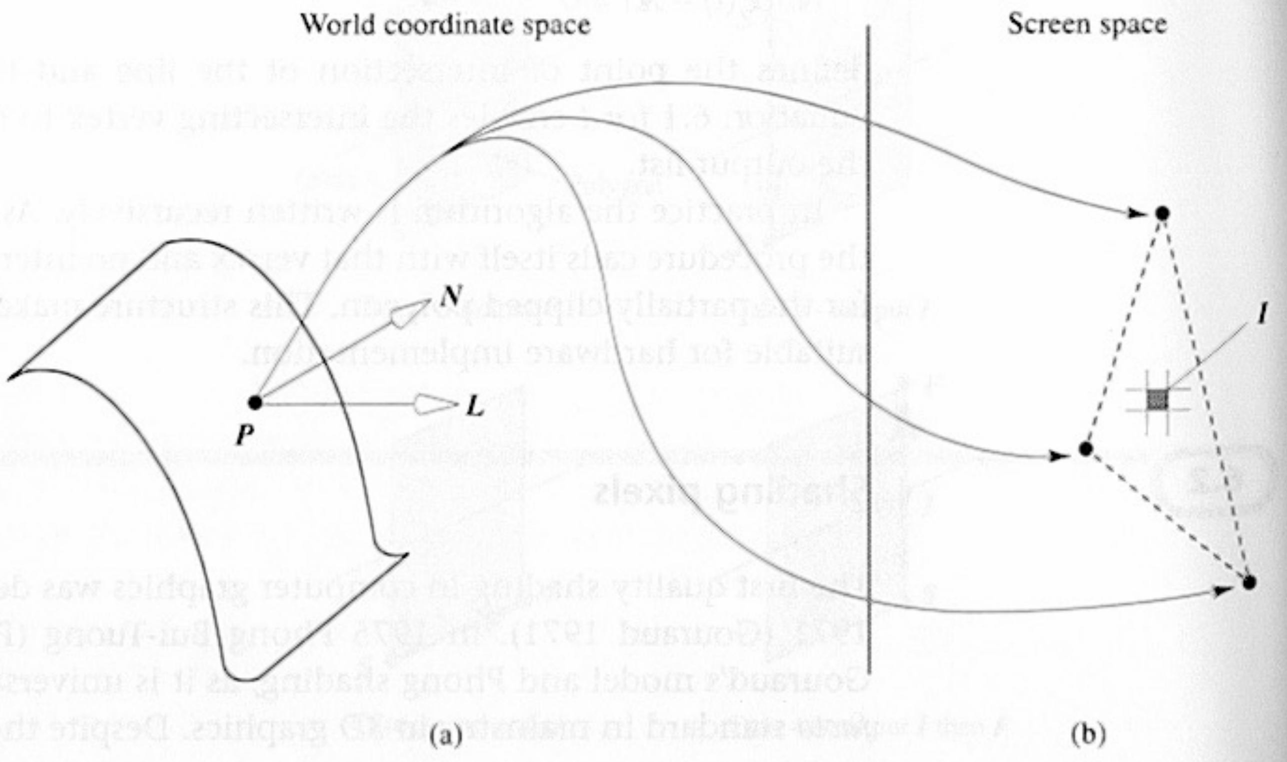


Figure 6.5 Illustrating the difference between local reflection models and shading algorithms. (a) Local reflection models calculate light intensity at any point ***P*** on the surface of an object. (b) Shading algorithms interpolate pixel values from calculated light intensities at the polygon vertices.

Multiple Light Sources

Obvious summation over *m* lights:

$$I = I_a k_a O_d + \sum_{1 \le i \le m} f_{att i} I_{p i} [\, k_d O_d (N \cdot L_i) + k_s (R_i \cdot V)^n]$$

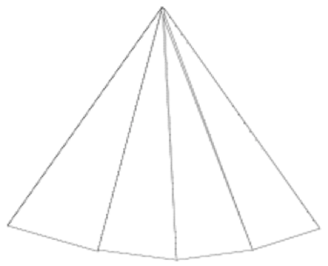
Shading Models

Surface color in this model = ambient + diffuse + specular

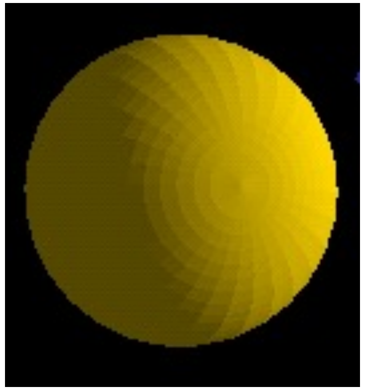
To shade triangles:

1) Per Triangle
2) Per Vertex
3) Per Pixel

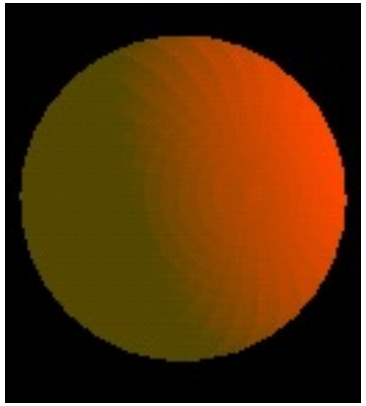
Shading Models: Per Triangle (Flat Shading)



- Compute one color for polygon
  - Use polygon normal in lighting eqs.
- Every pixel is assigned same color

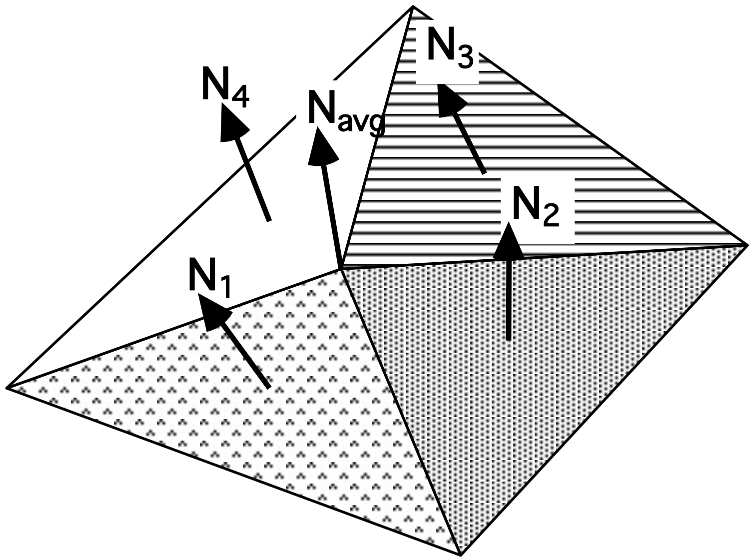


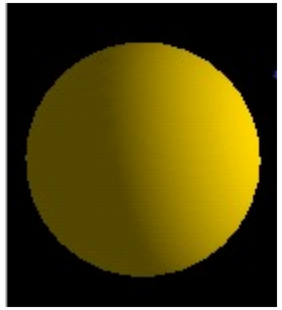
- Fast and simple
- Shade of polygons independent

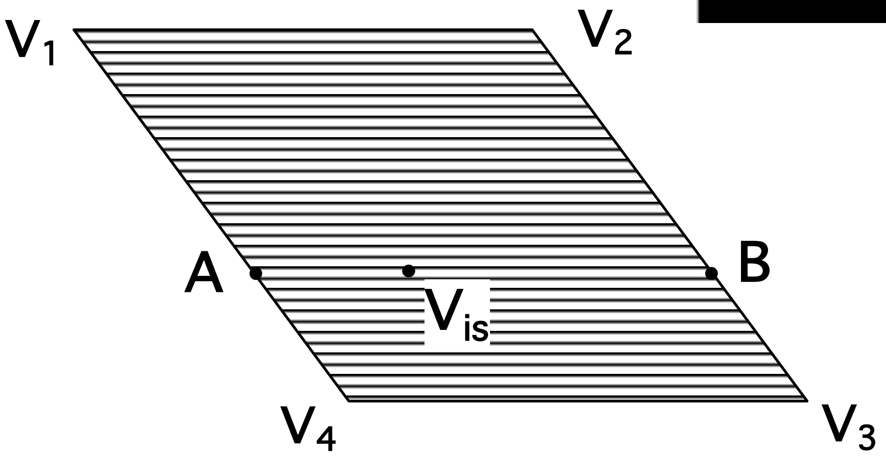


Shading Models: Per Vertex (Gouraud Shading)

- Compute vertex normals
  - Average normals of abutting polygons
- Use vertex normal in lighting eqs.
- Linearly interpolate vertex intensities
  - Along edges
  - Along scan lines







Gouraud Shading

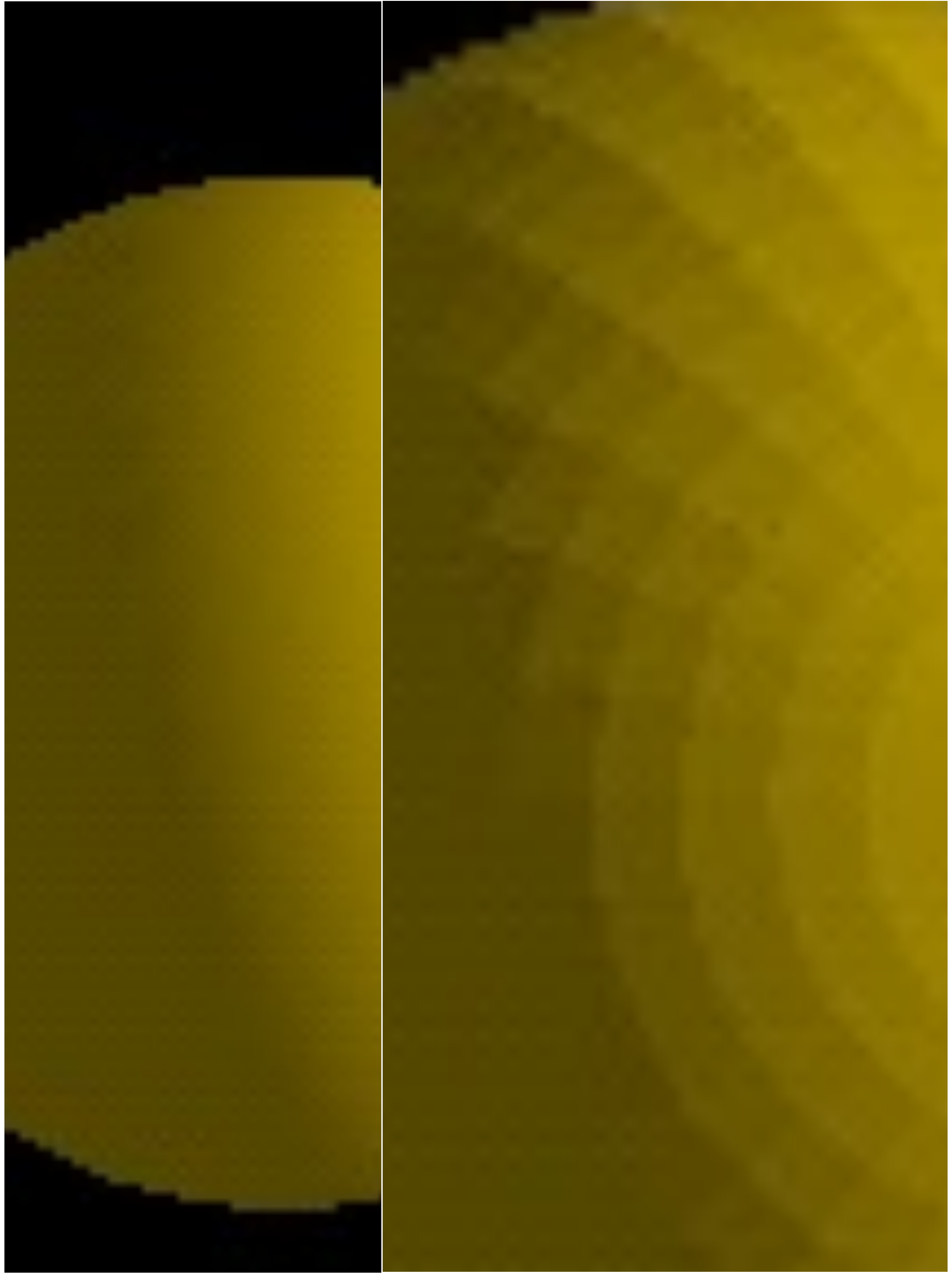
Often appears dull, chalky

- Lacks accurate specular component
  - If included, will be averaged over entire polygon

Flat Shading

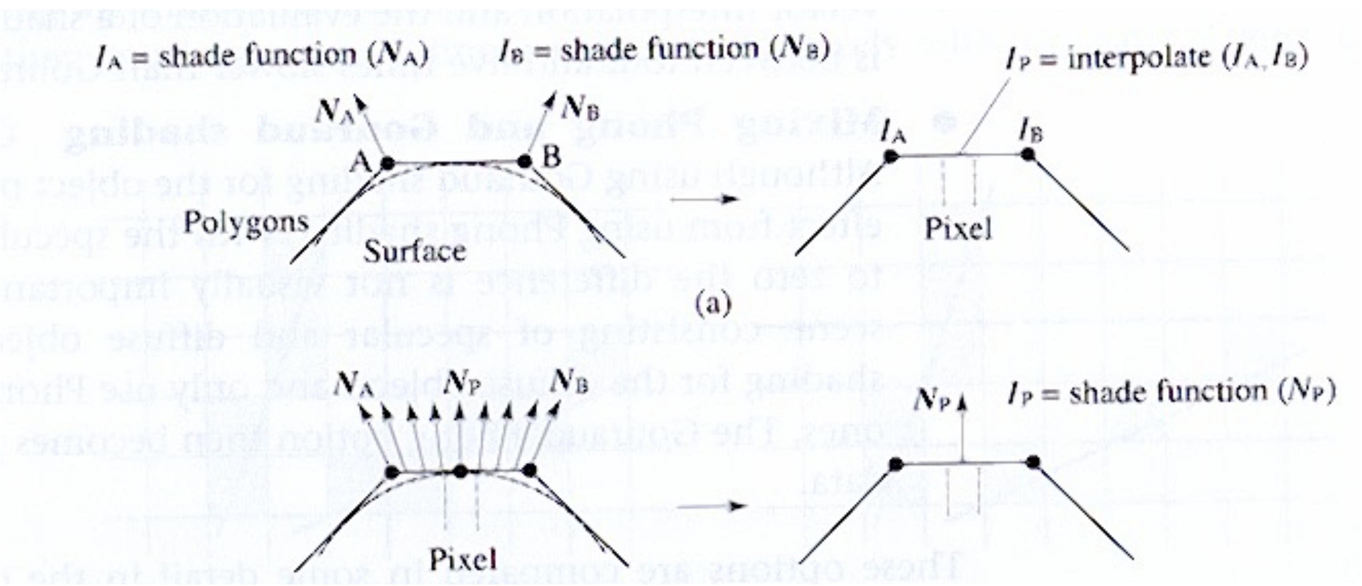
Mach banding

- Artifact at discontinuities in intensity or intensity slope



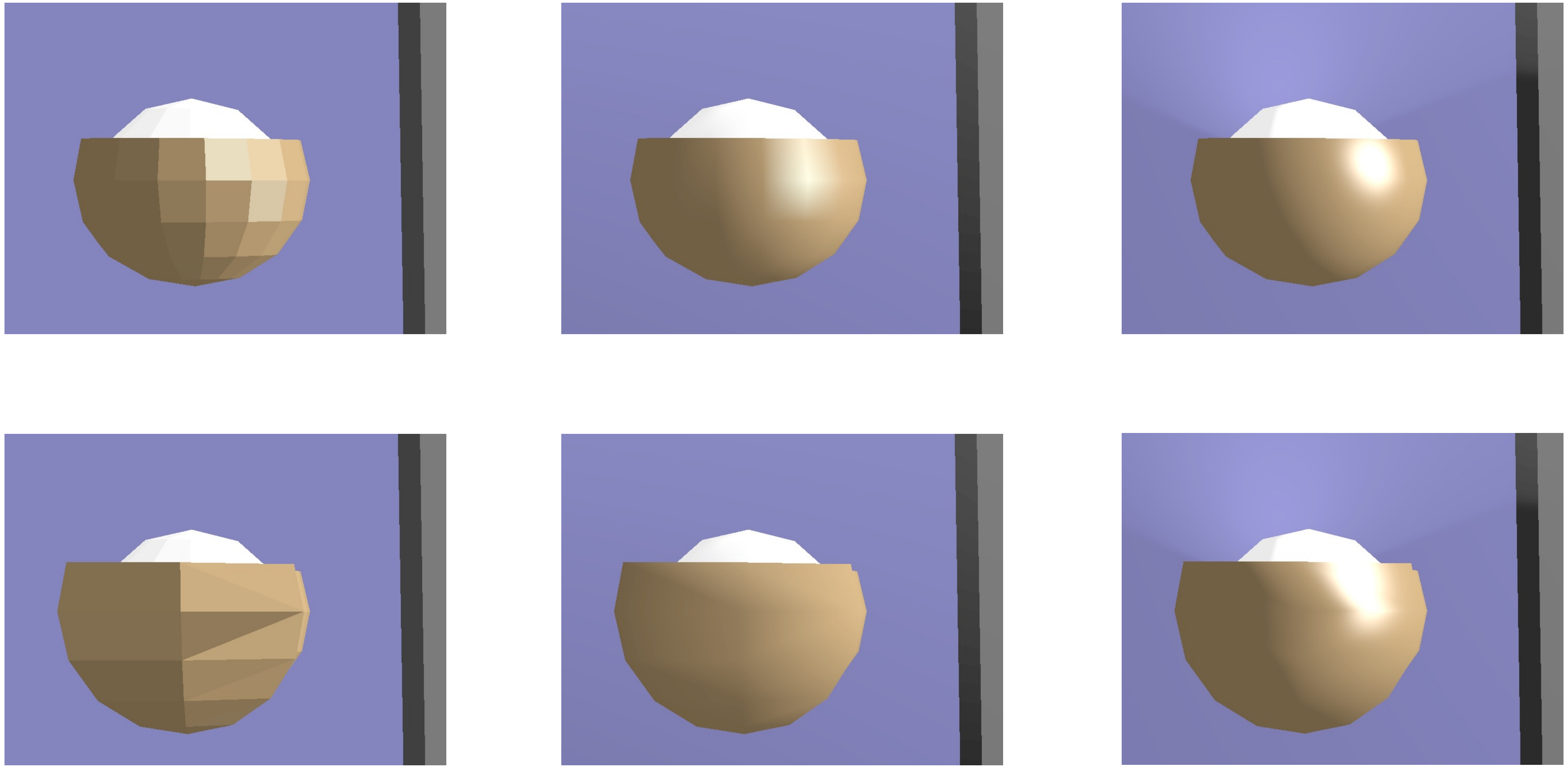
Shading Models: Per Pixel (Phong Shading)

- Linearly interpolate vertex normals
  - Compute lighting eqs. at each pixel
    - Normals must be backmapped to WC



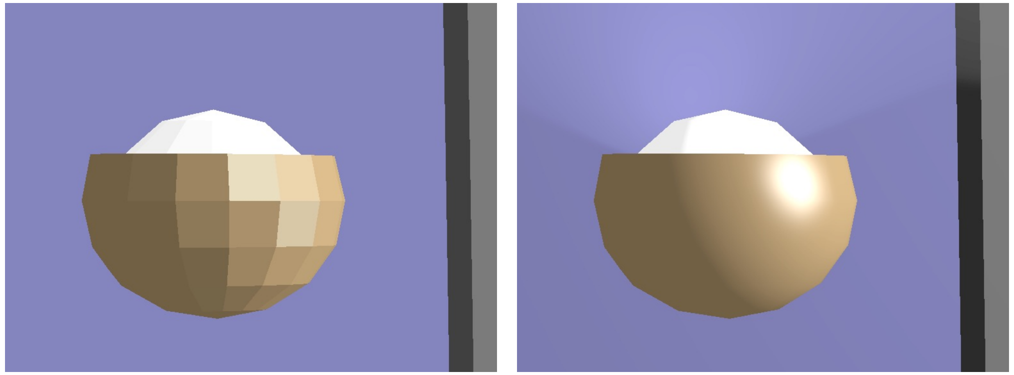
- Can use specular component

Closeup: Flat, Gouraud, Phong

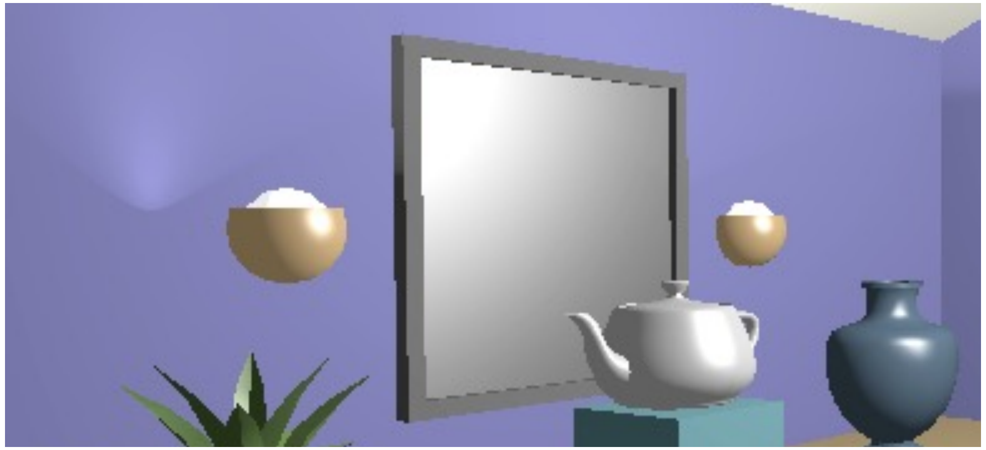


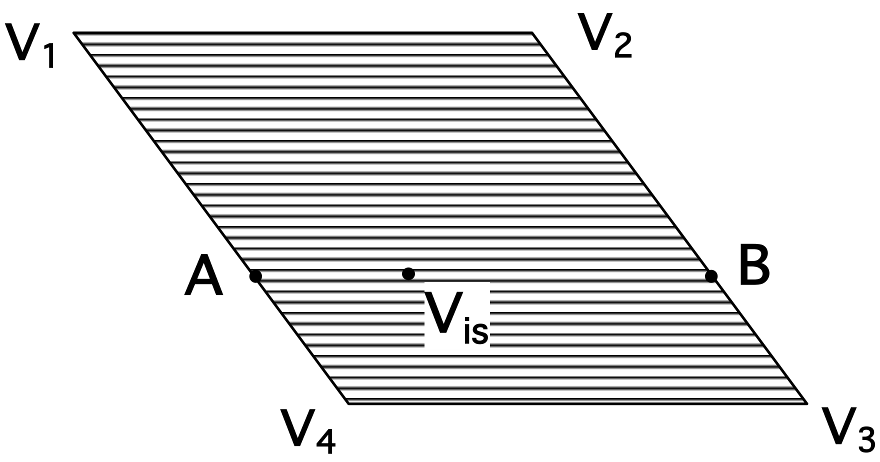
Problems with Interpolated Shading

- Polygonal silhouette



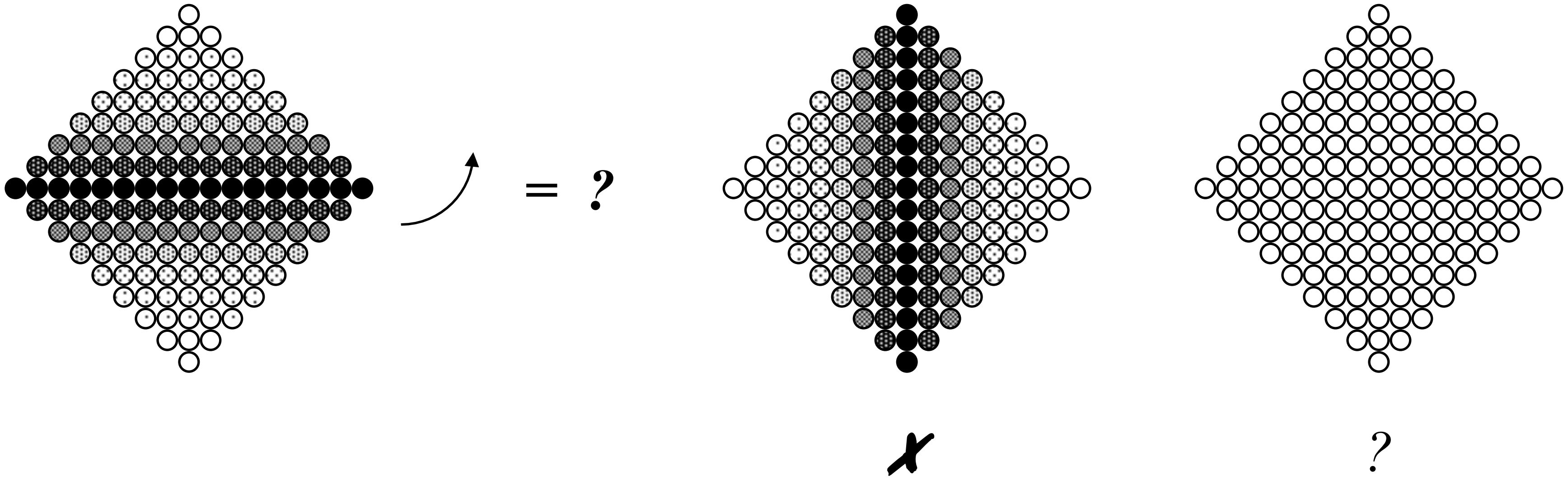
- Perspective distortion





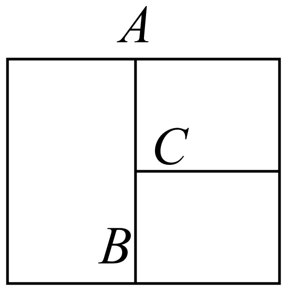
Problems with Interpolated Shading

- Scanline/orientation dependent
  - Creates temporal aliasing when used to render animation frames:



Problems with Interpolated Shading

- Shared vertices



- Unrepresentative vertex normals
  - Missed specular highlights
  - Missed geometry