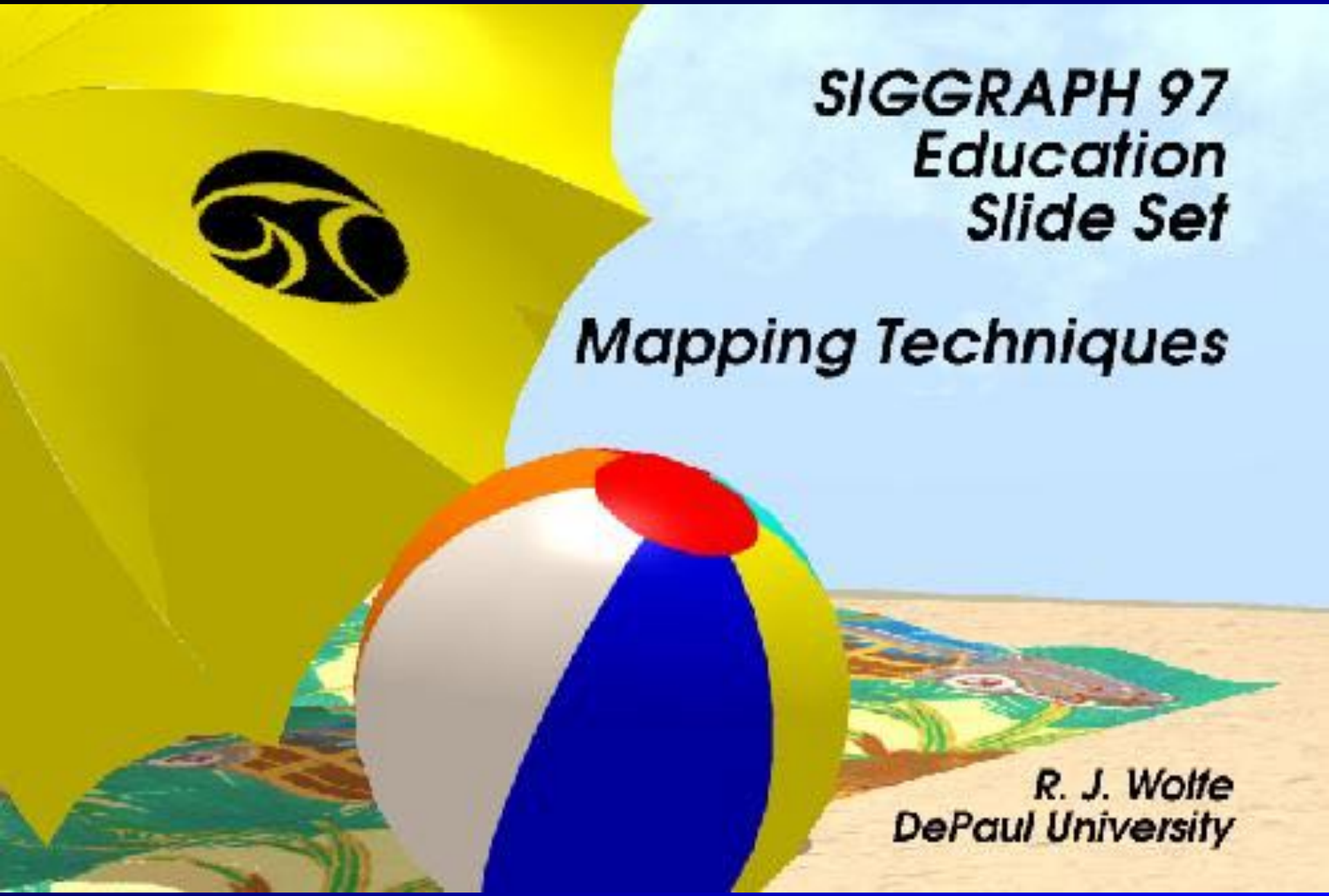
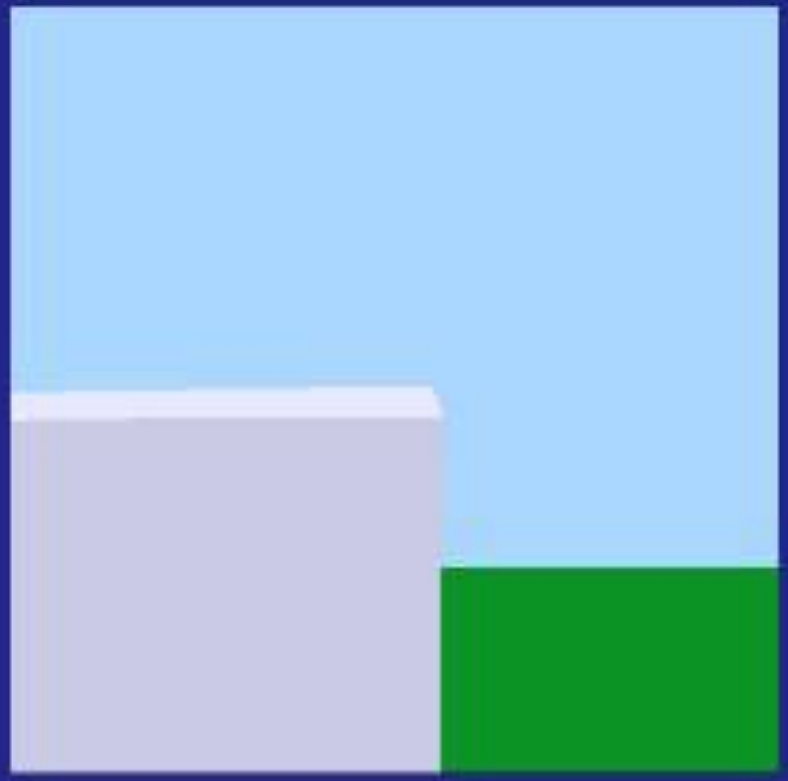

SIGGRAPH 97
Education
Slide Set
Mapping Techniques
R. J. Wolfe
DePaul University

Texture mapping



World/object coordinates

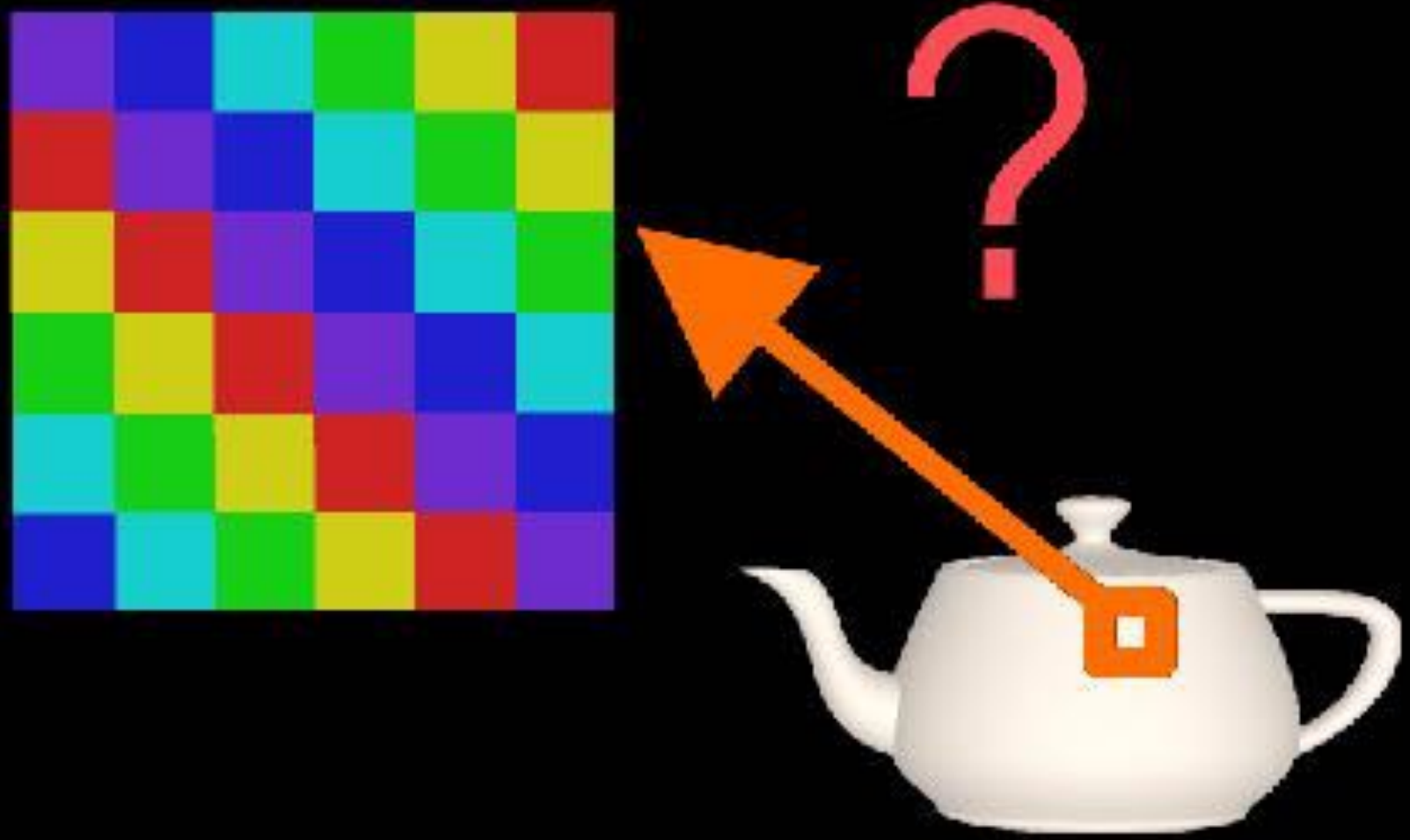
2D/3D

2D
mapping

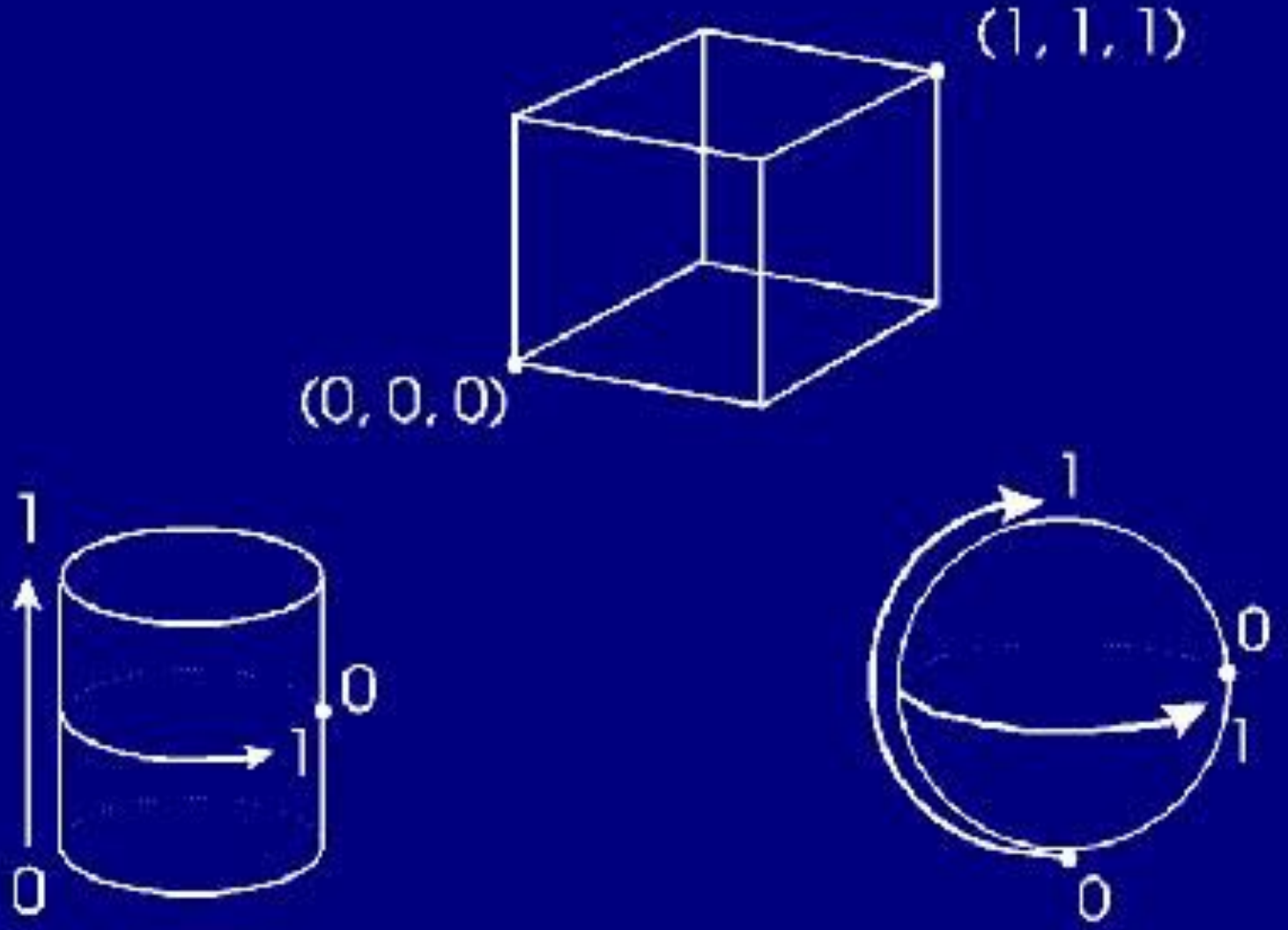
3D
mapping

Sources : scanners, raytracers

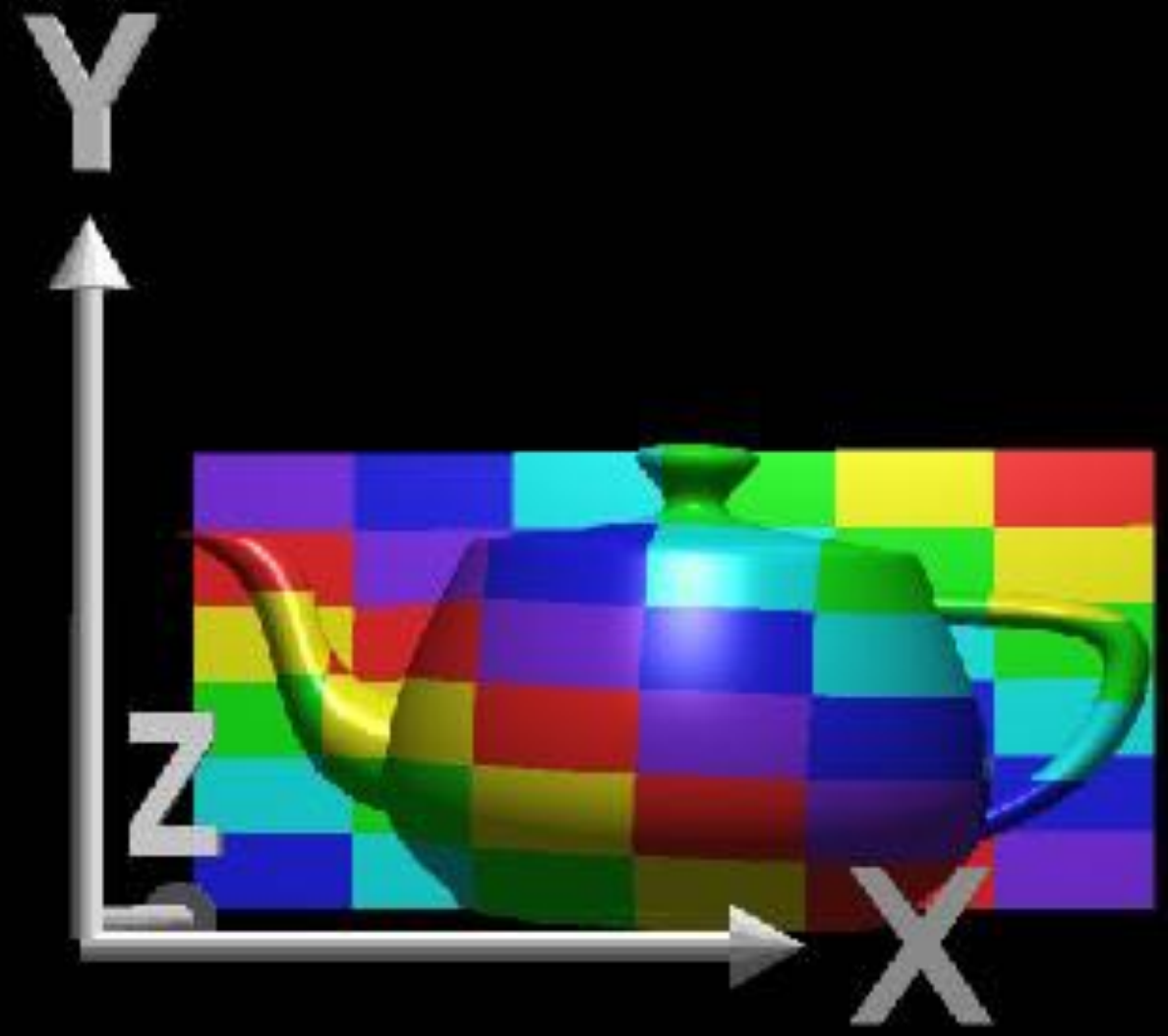
Mapping one object pixel to a texture pixel



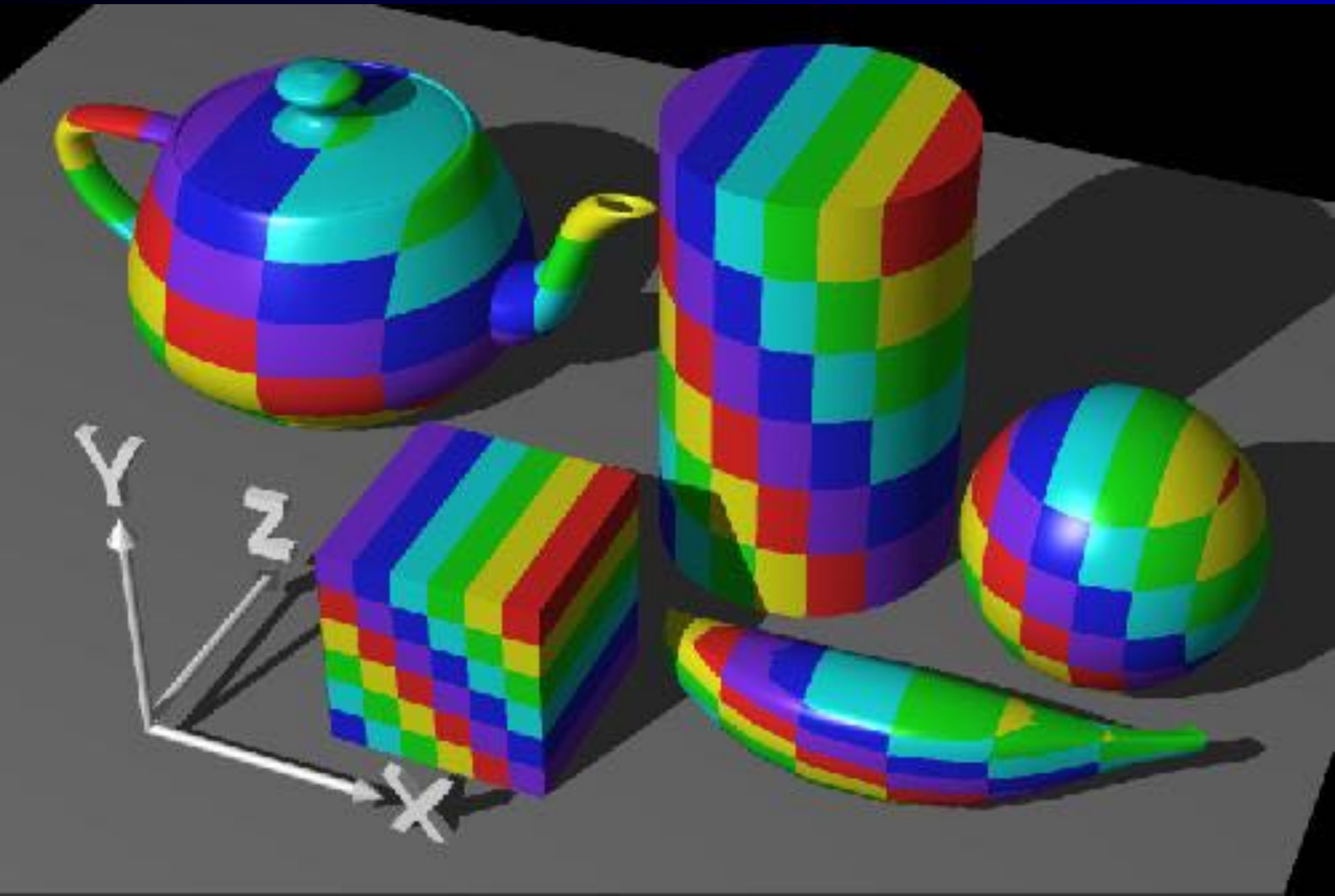
Object parameterization



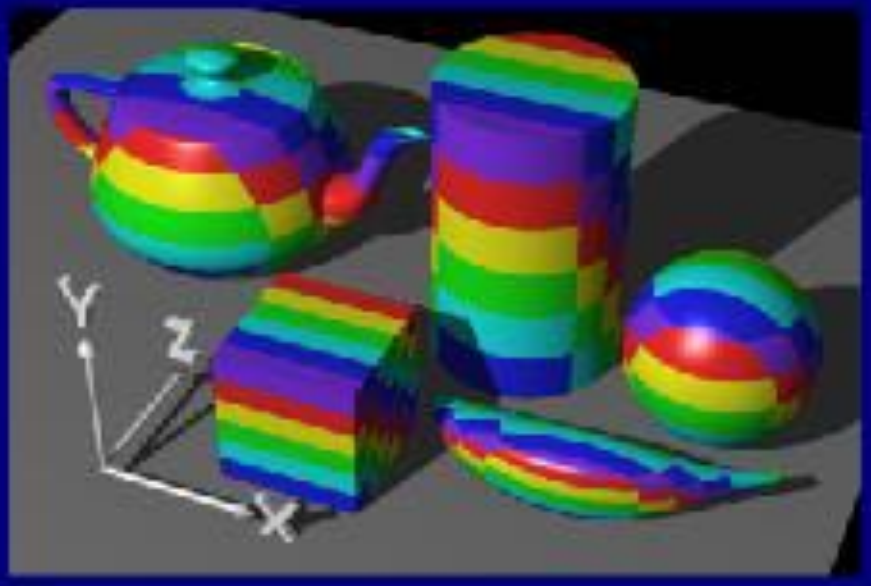
Planar map shape

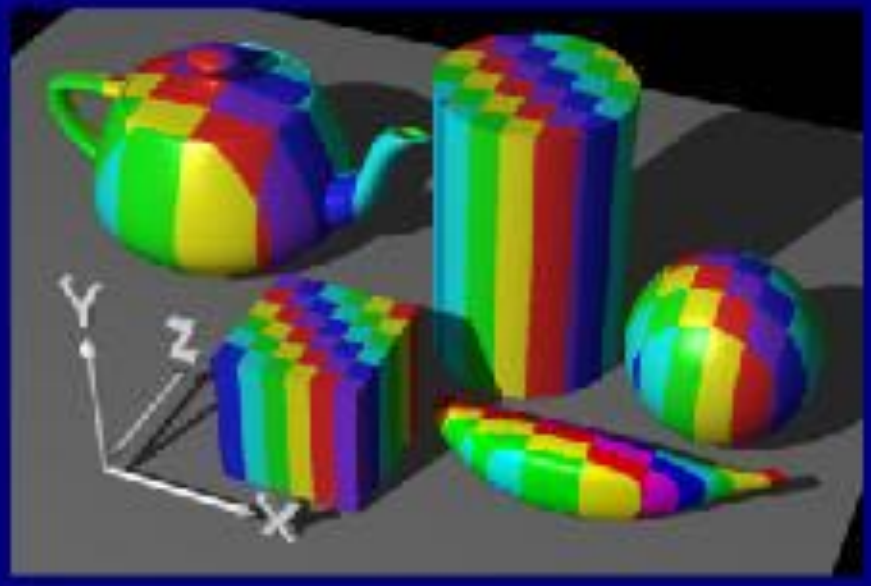


Planar map shape



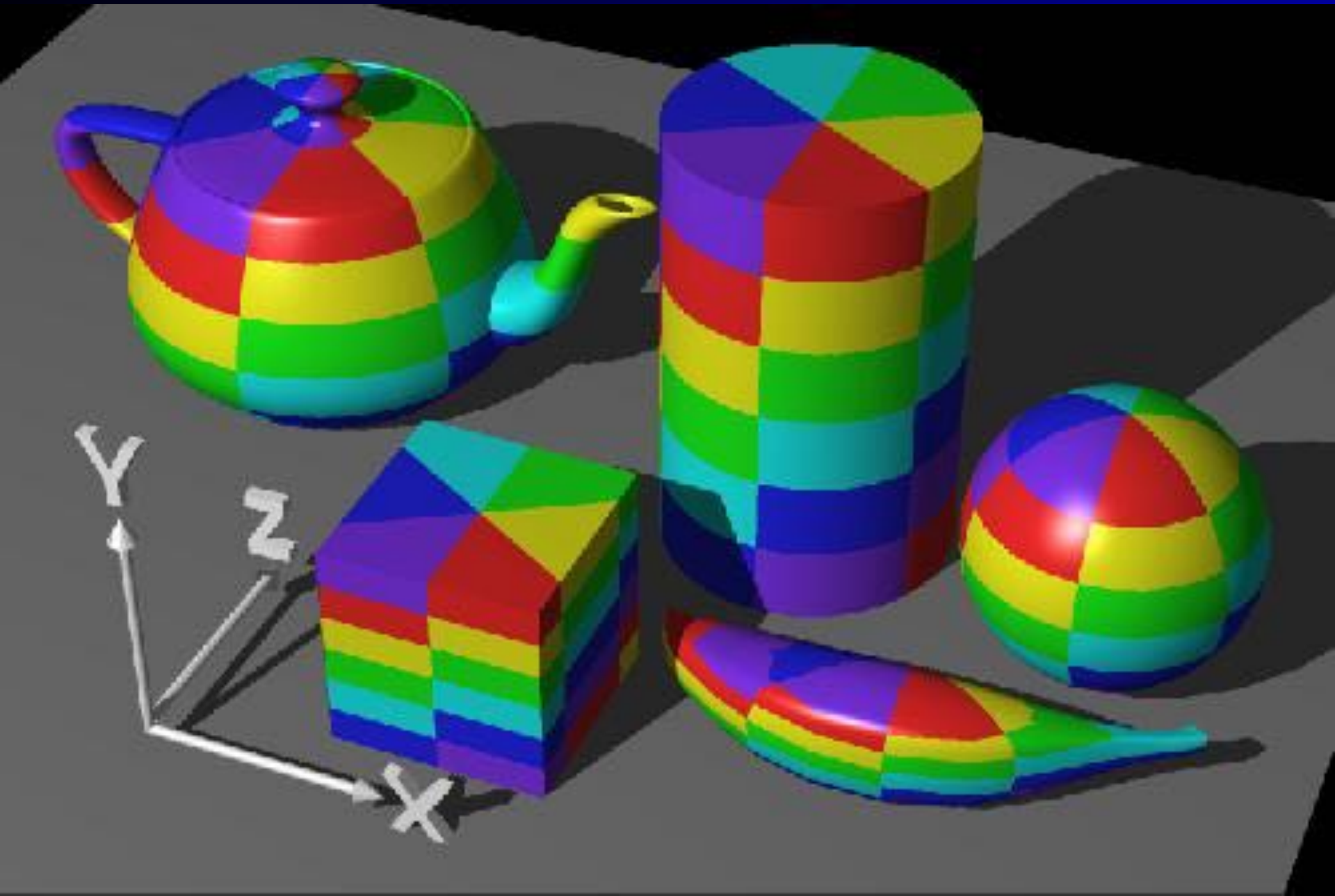
Planar map shape



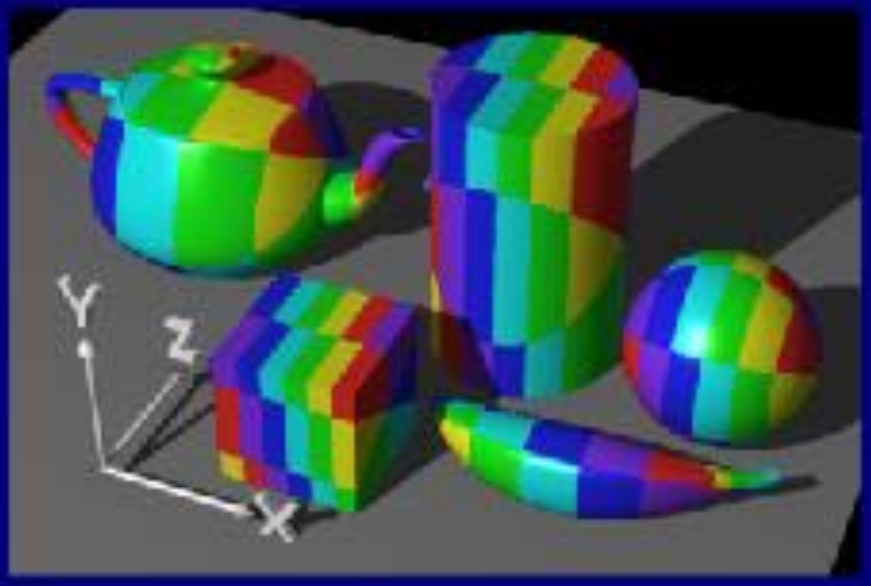


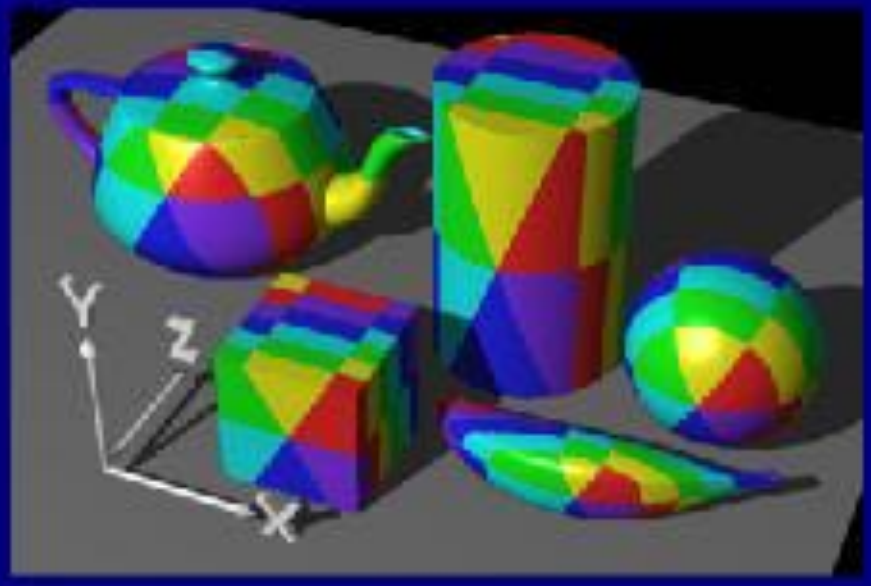
Cylindrical map shape

Cylindrical map shape

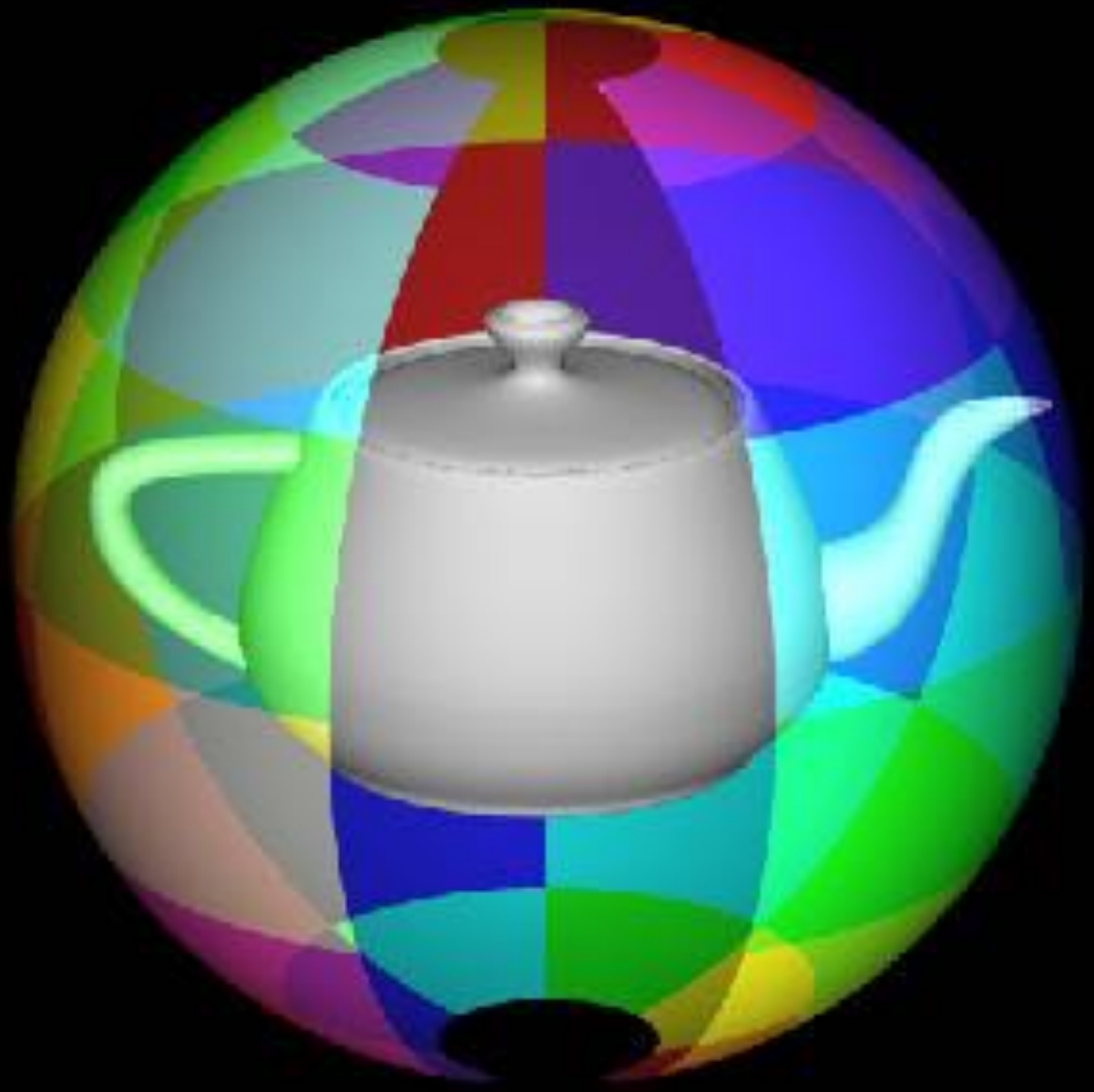


Cylindrical map shape

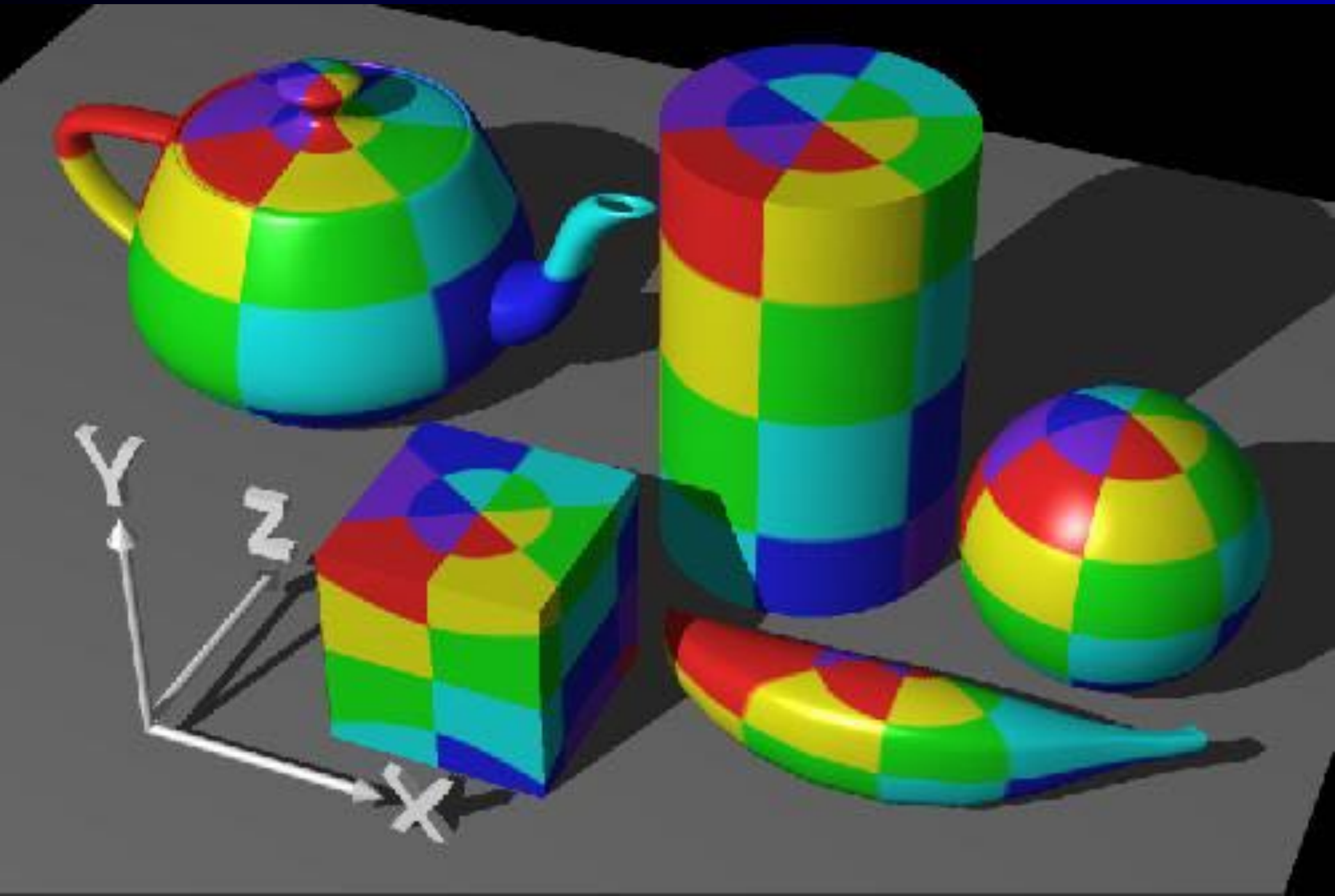




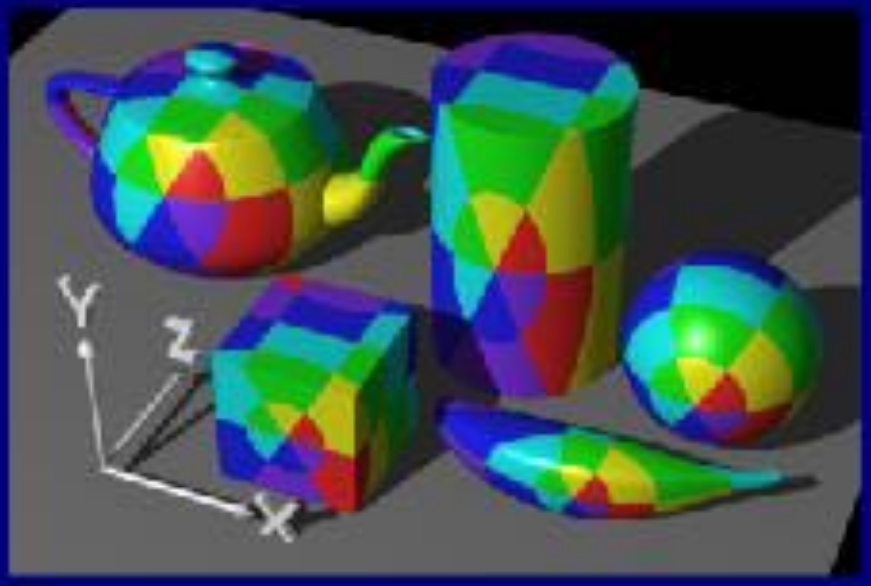
Spherical map shape

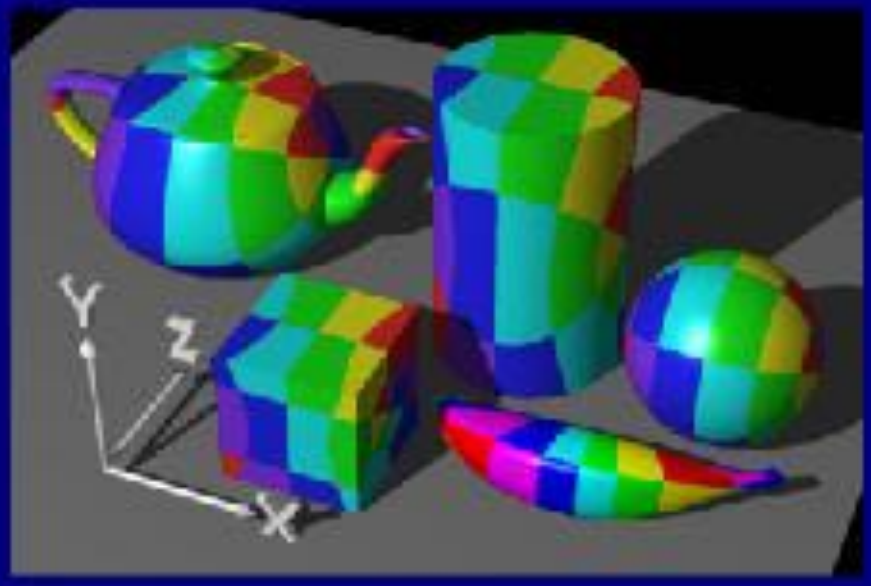


Spherical map shape

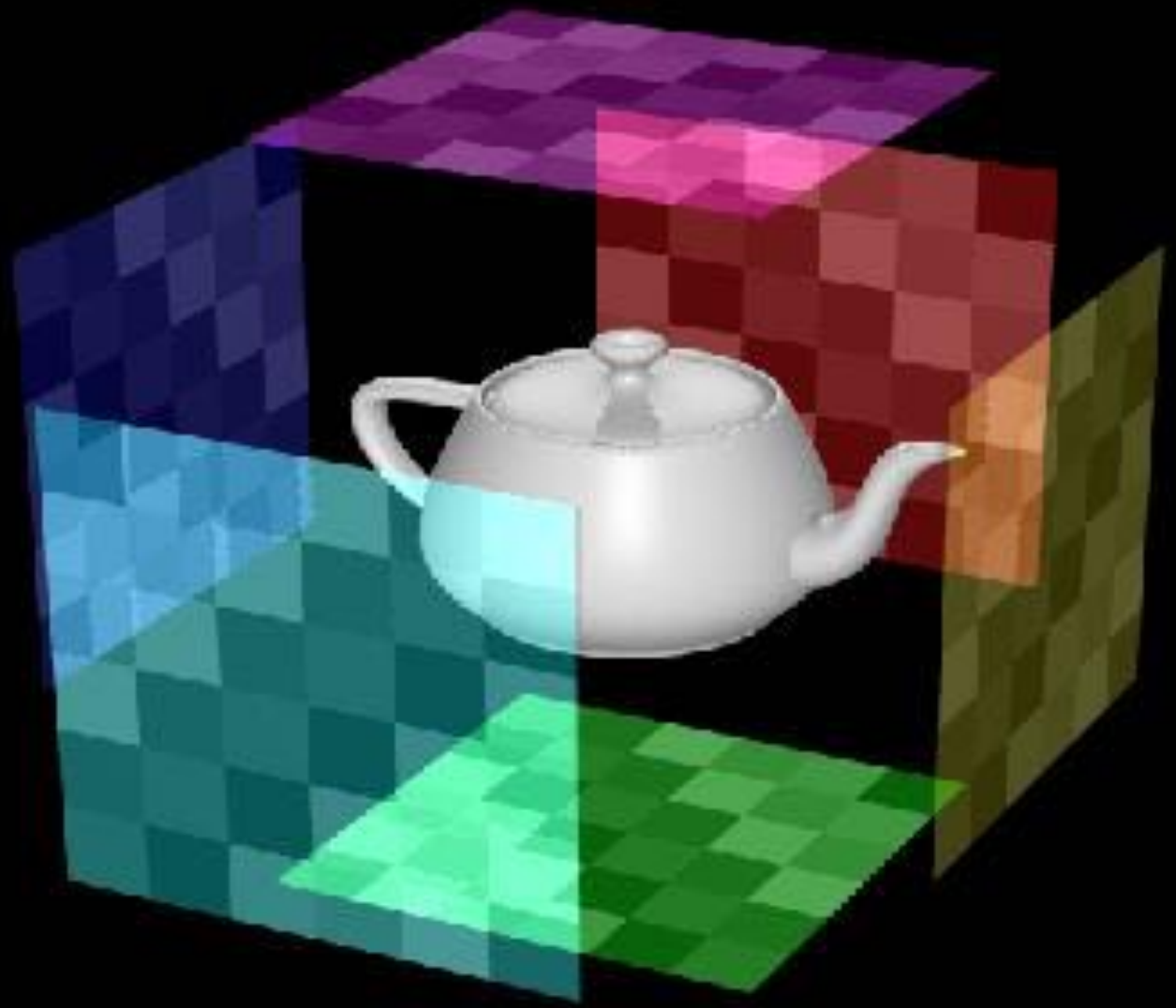


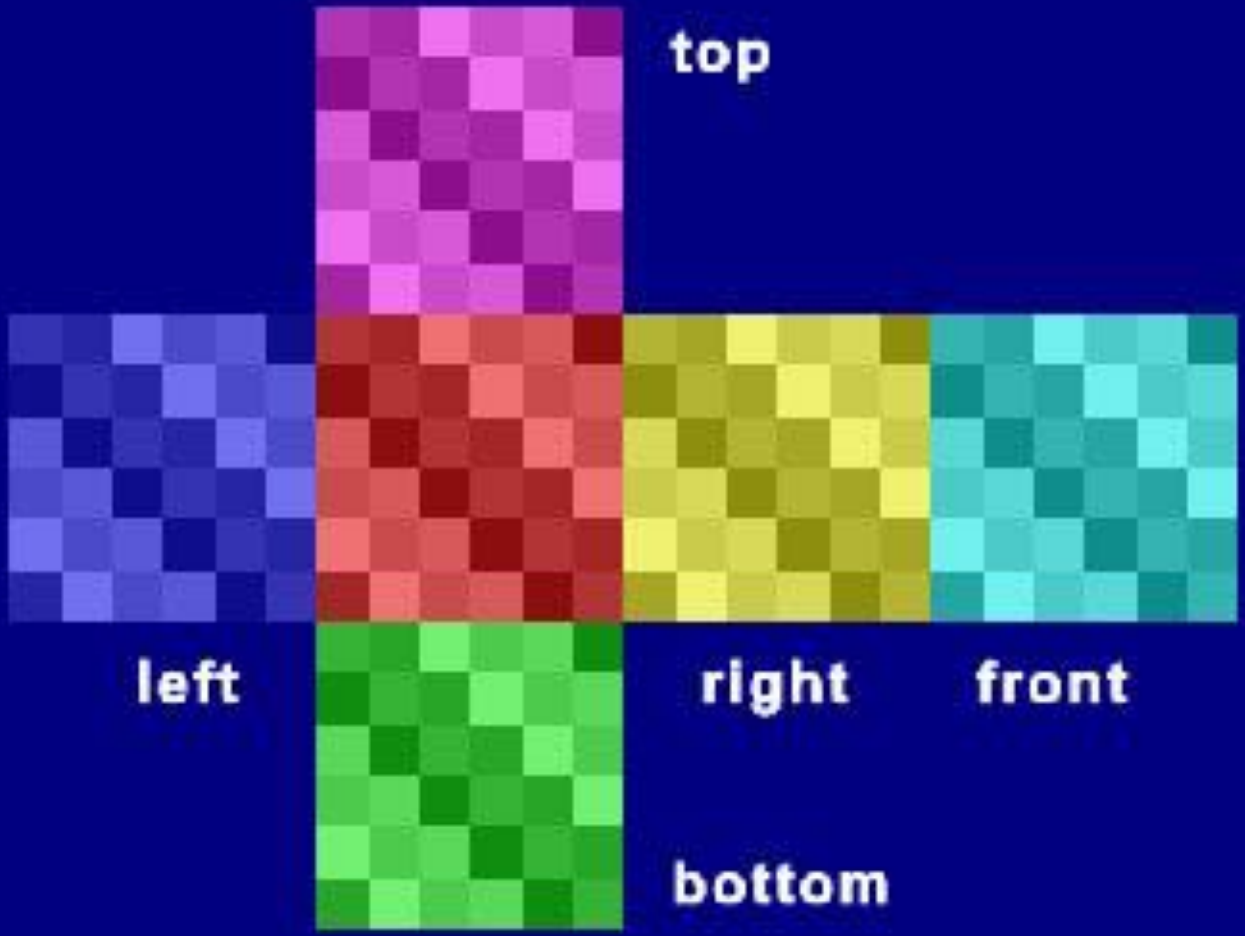
Spherical map shape



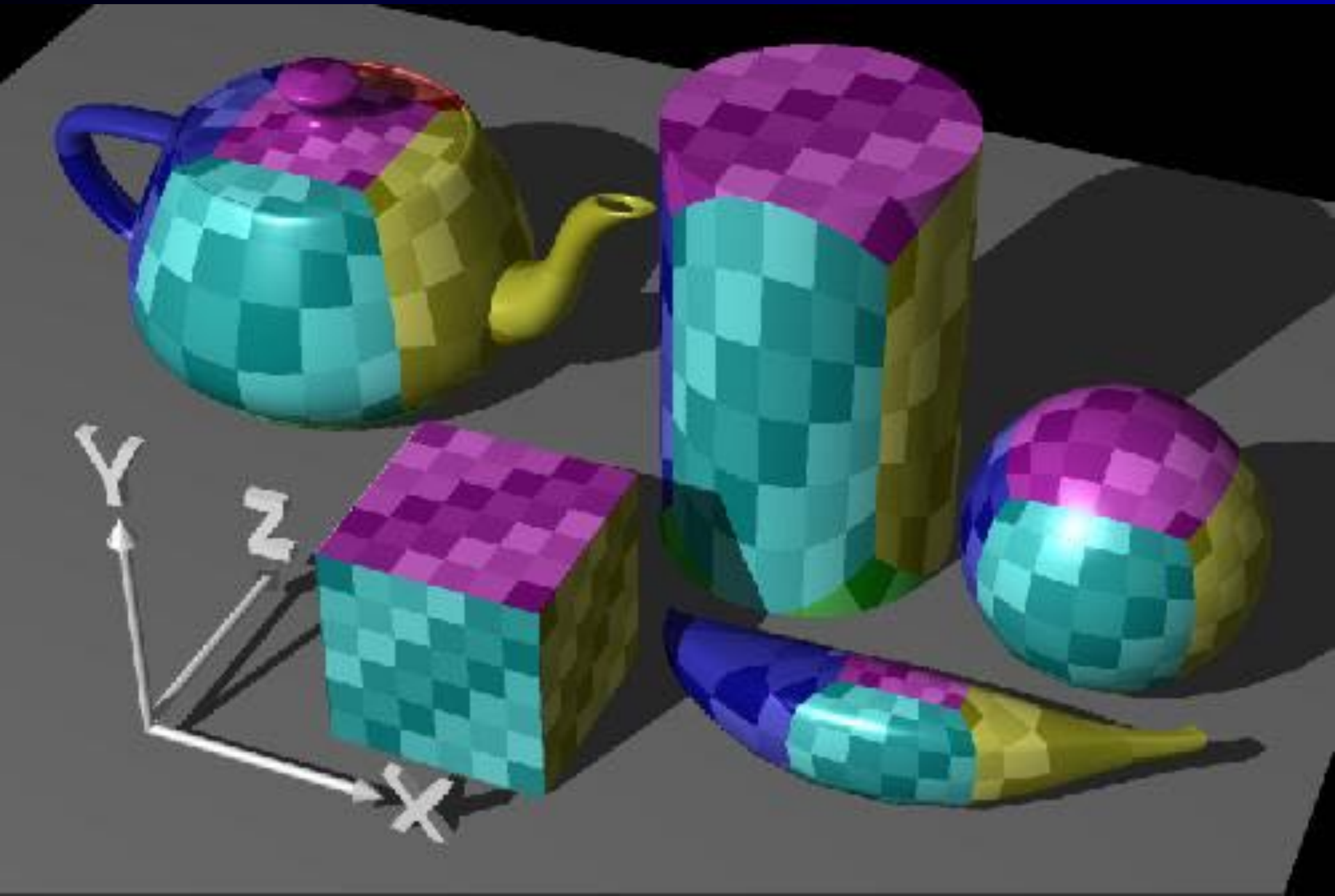


Cube map shape




top
left
right
front
bottom

Cube map shape



What do we get from the texture?

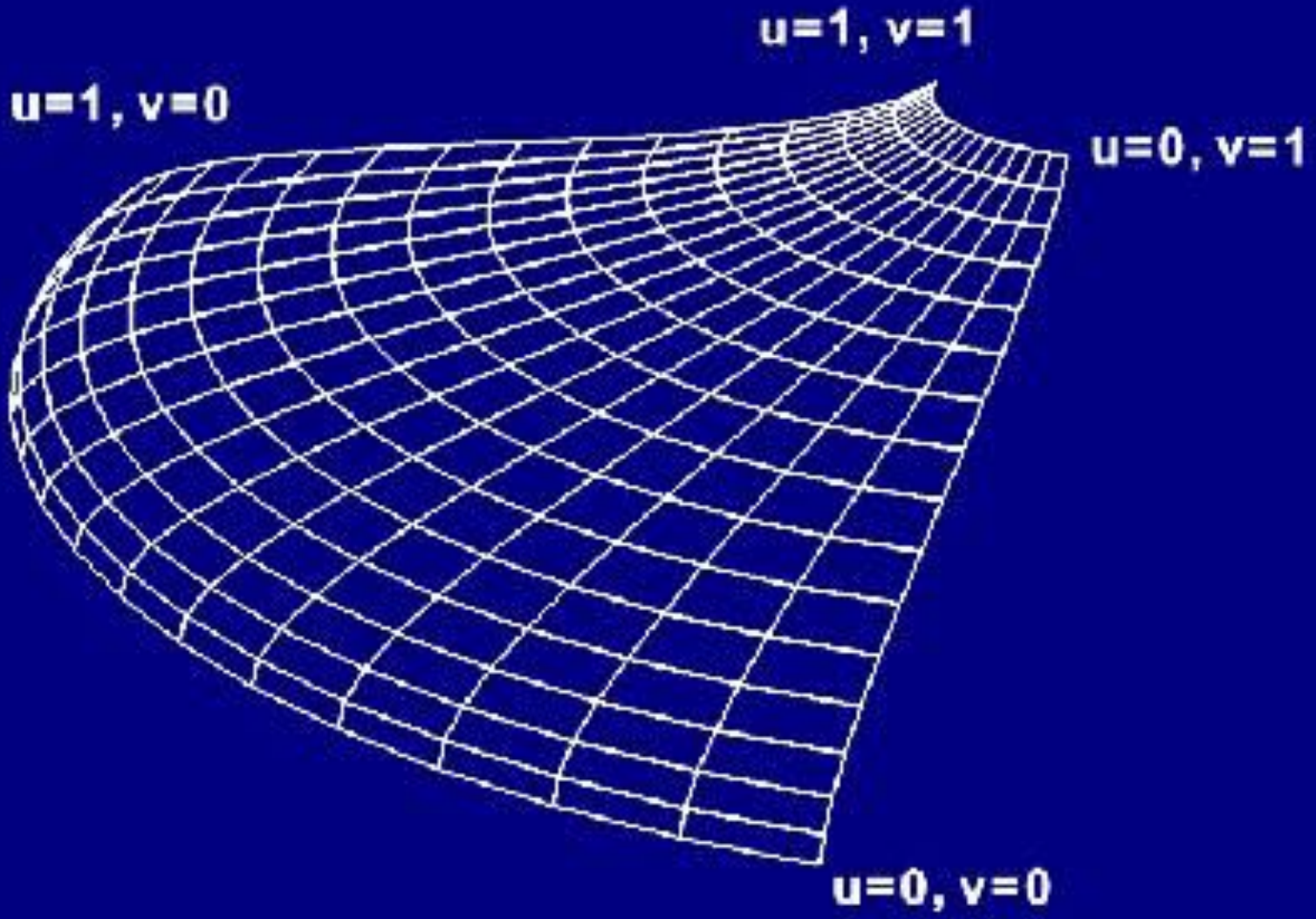
position

surface normal

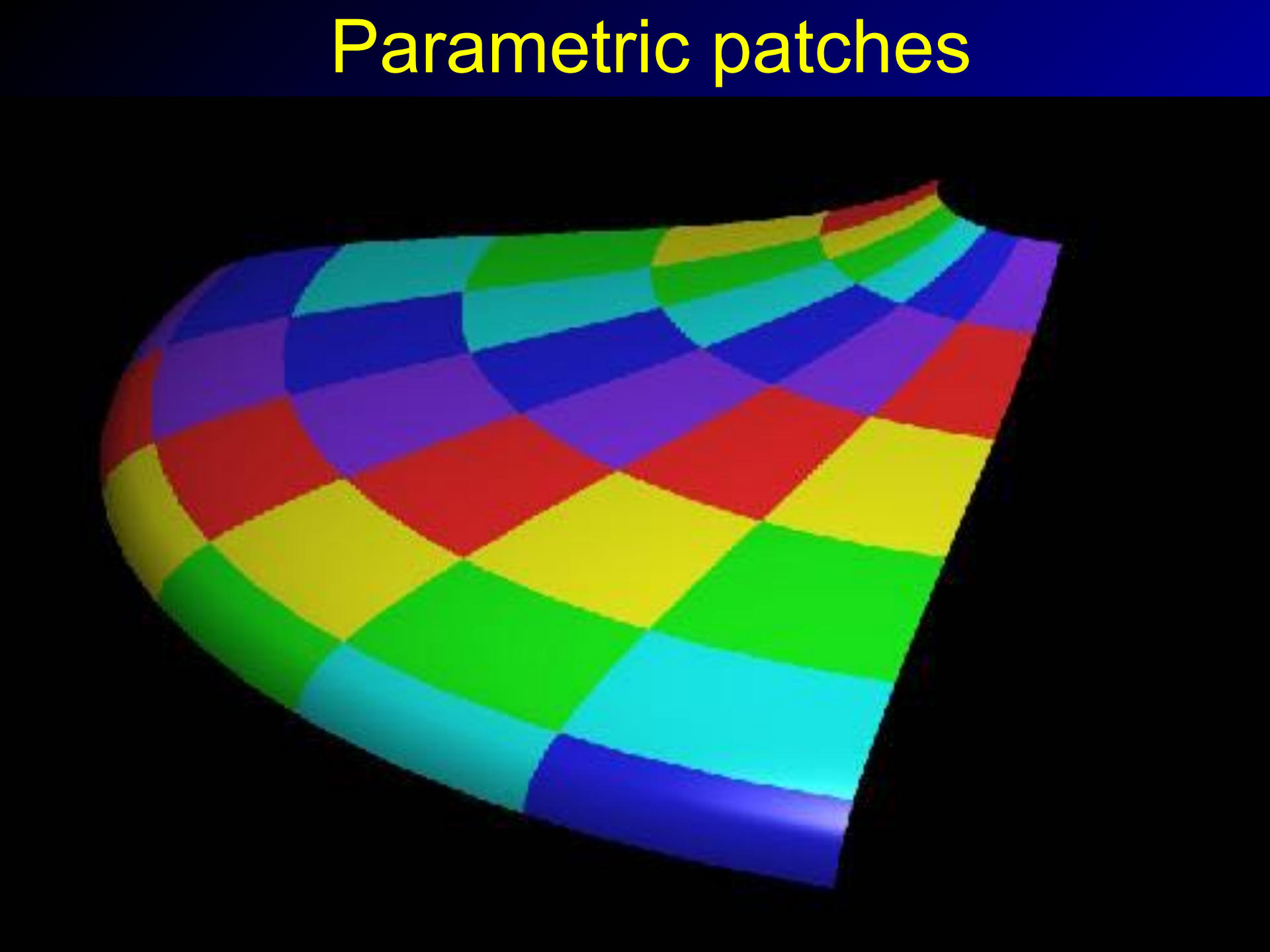
from centroid

reflection

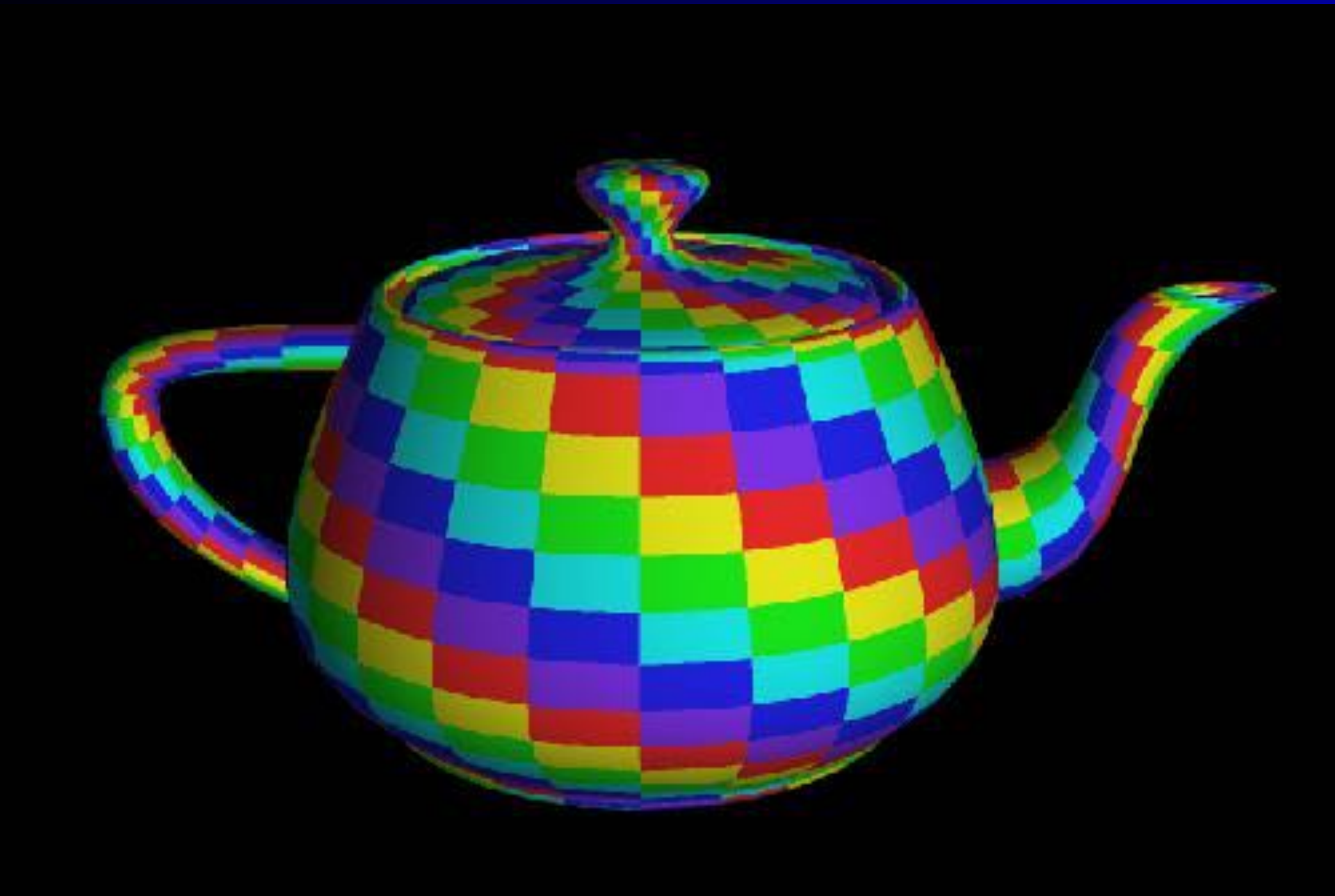
Parametric patches



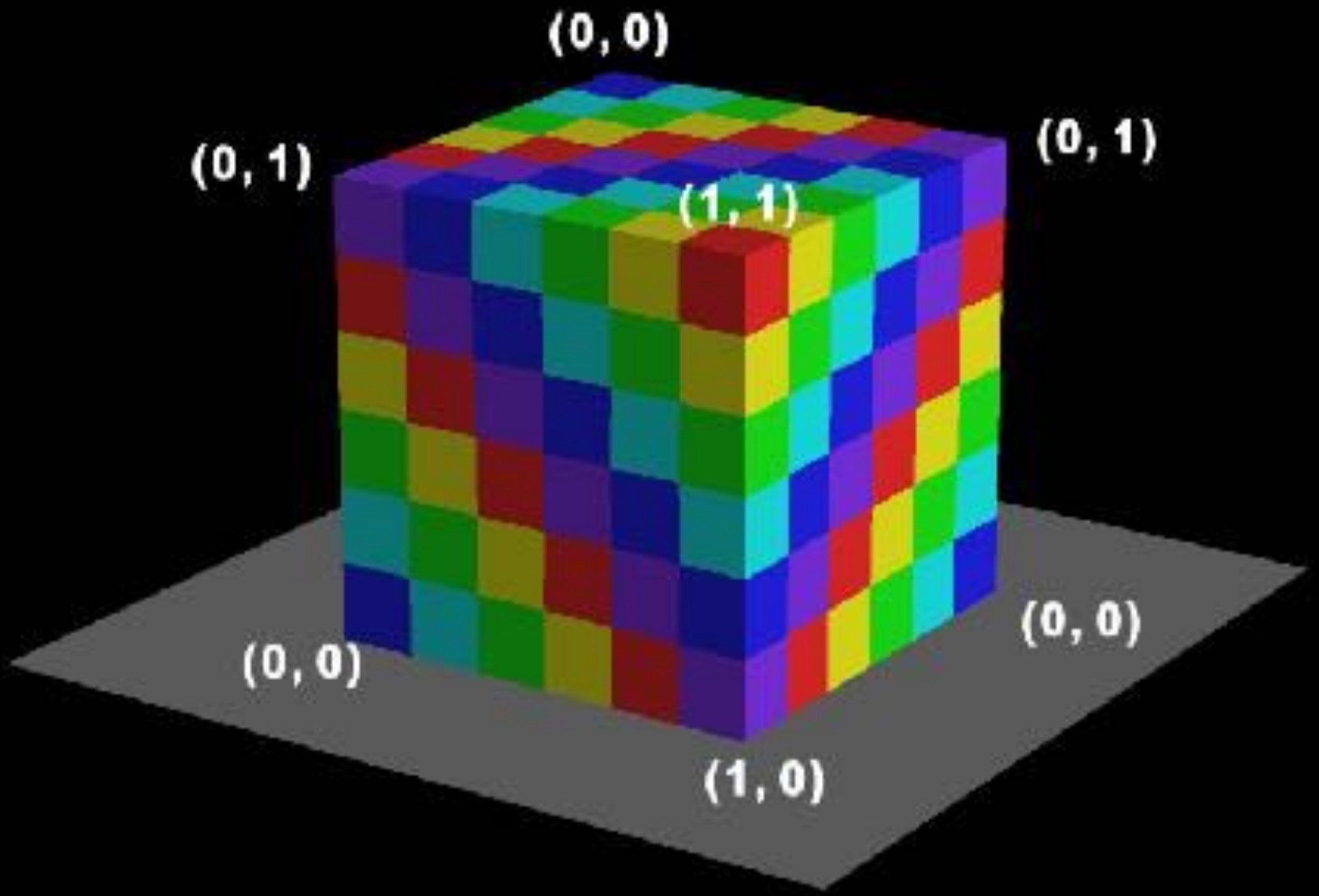
Parametric patches



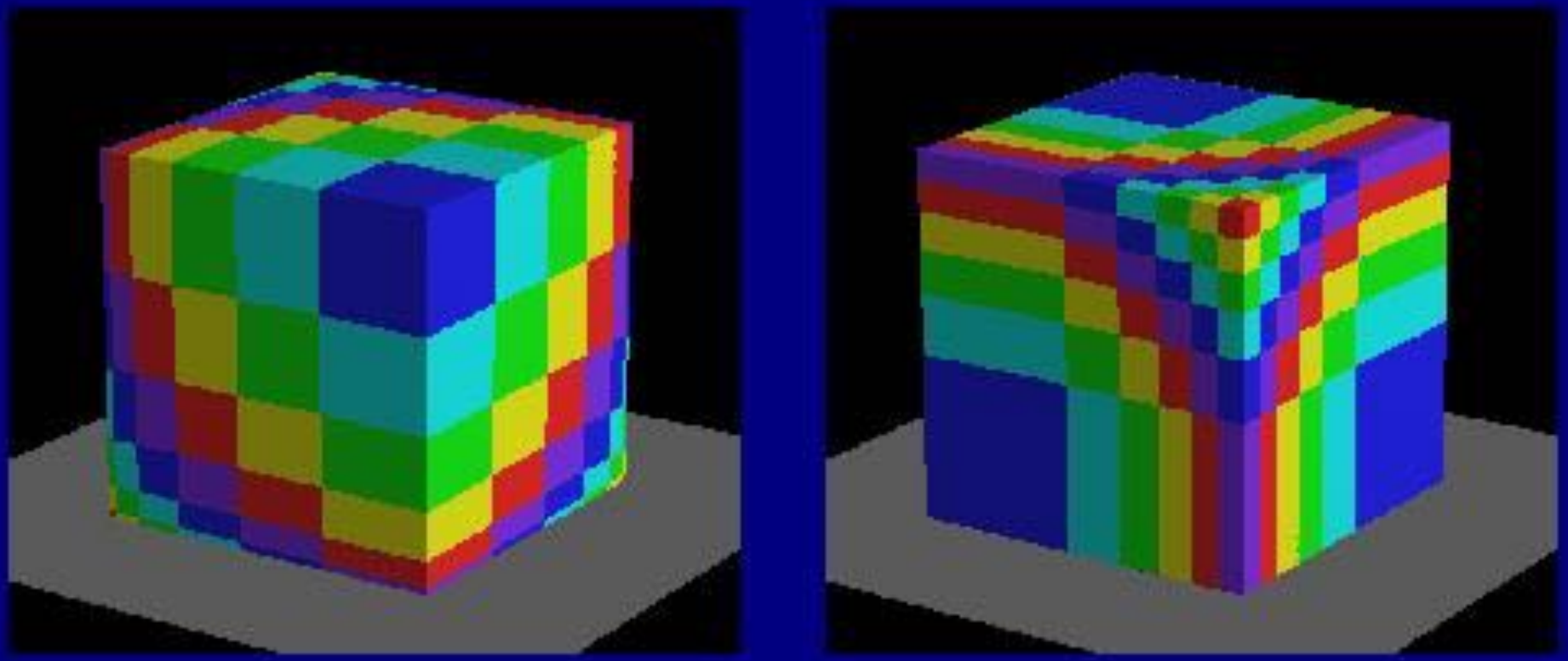
Parametric patches



Parameterized cube



Non-linear mapping

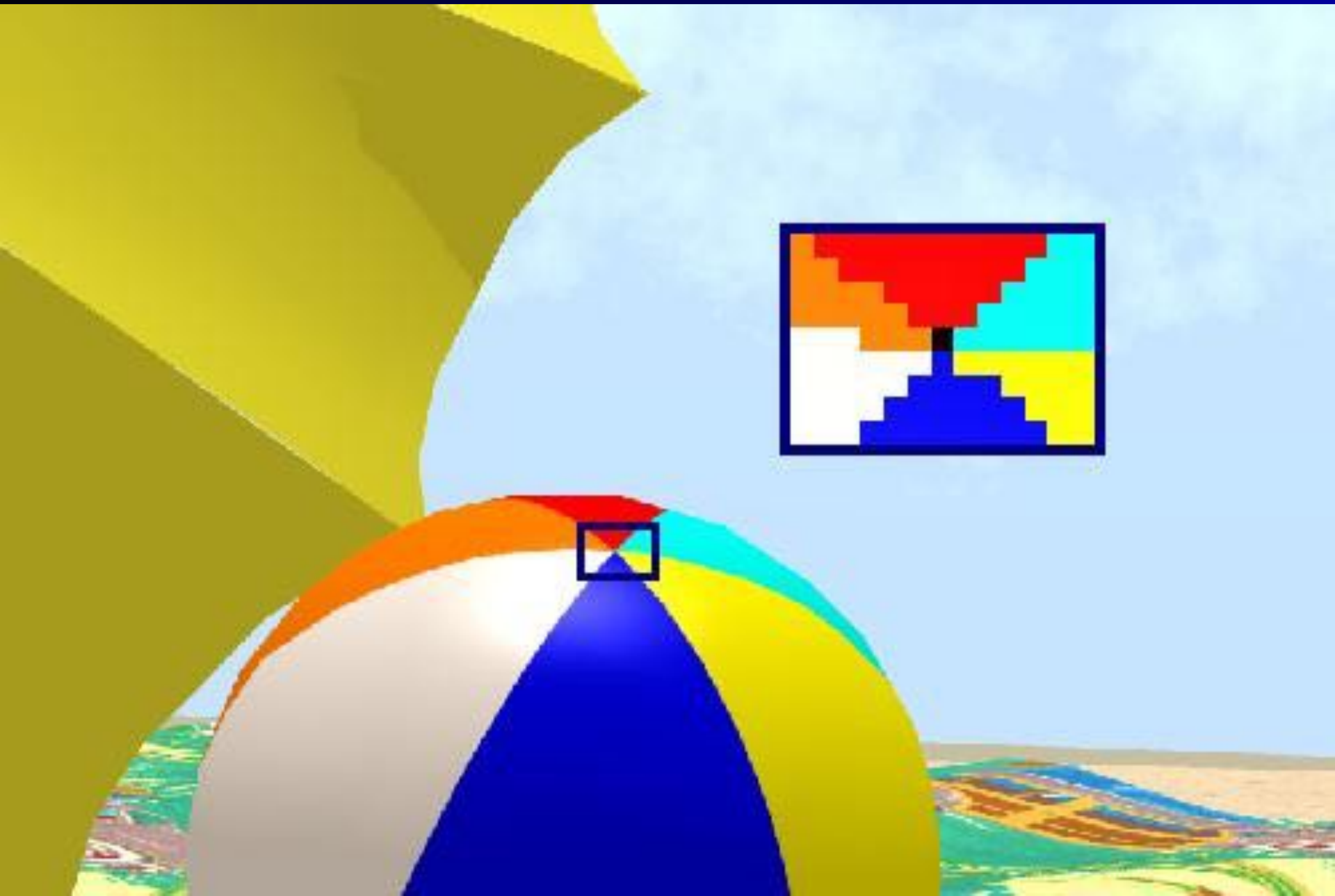


Triangular meshes

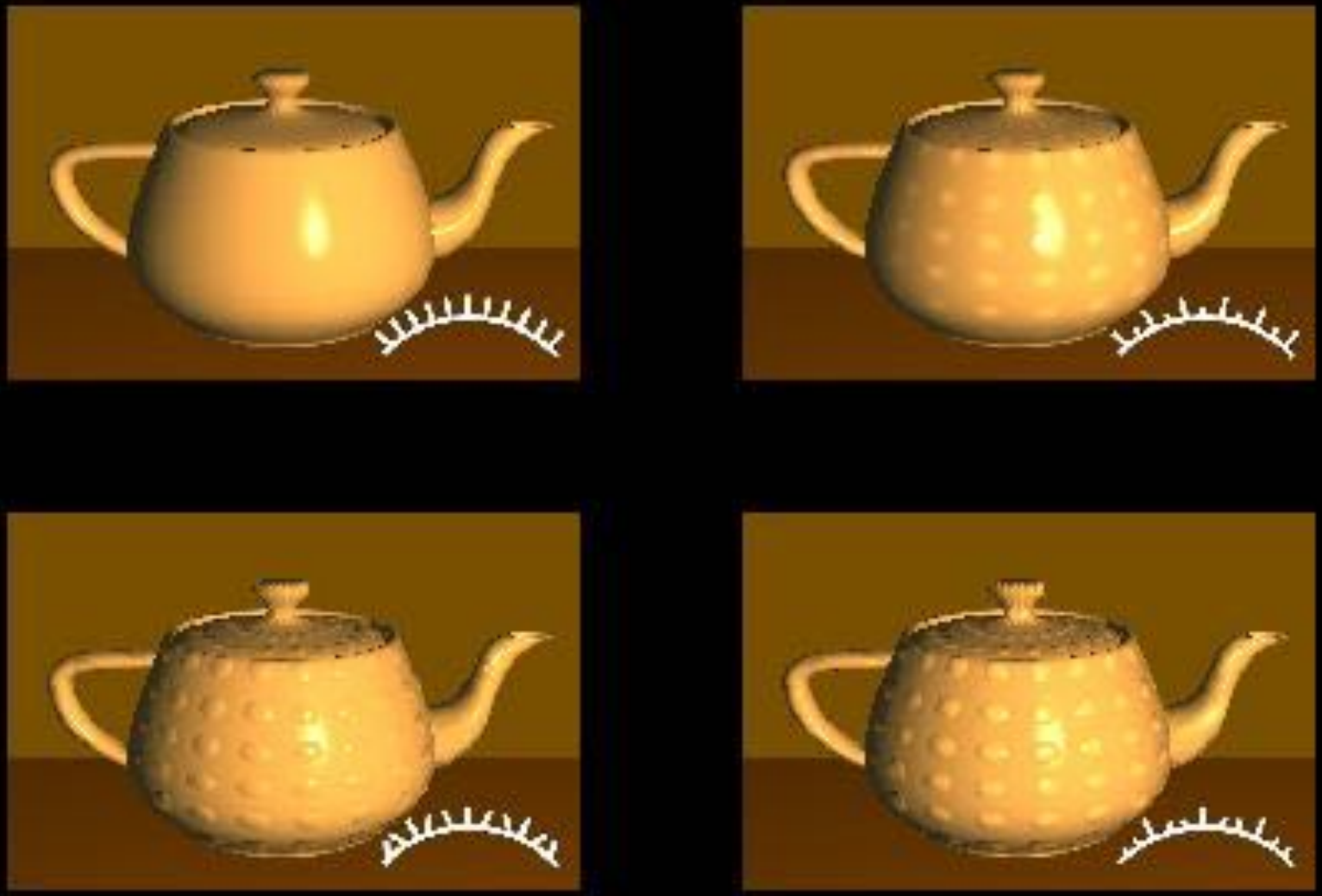
- One texture coordinate per vertex
- Regular parameterization of the mesh
- Requirements:
  - Continuous
  - Small angular deformations
  - Small area deformations
  - Covers the entire mesh
  - In practice: at most two

Triangular mesh example

Singularities (poles)



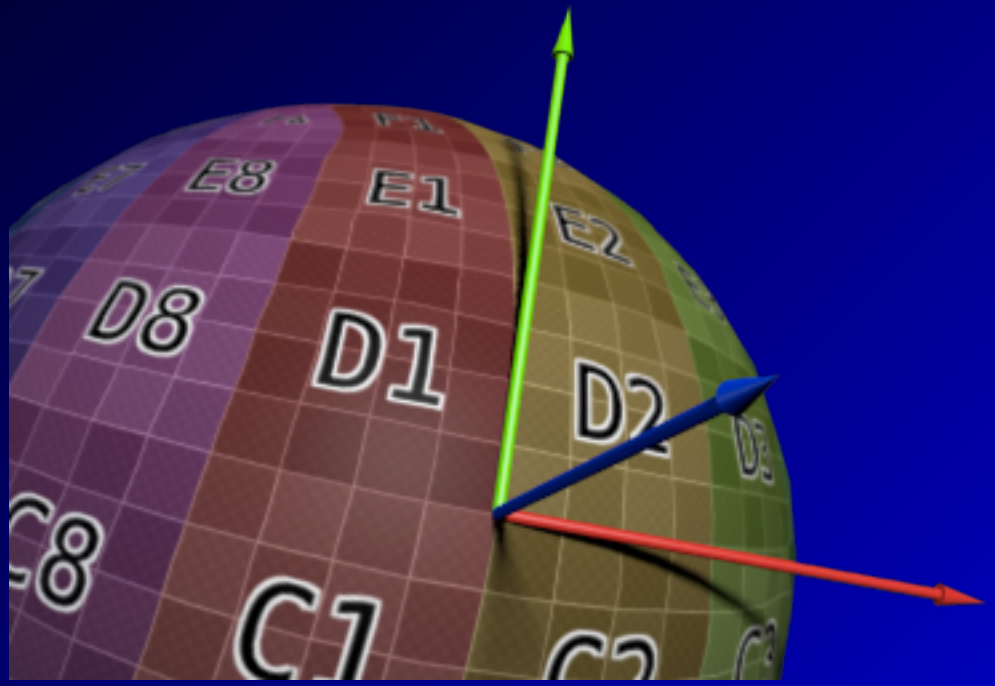
Bump mapping



Examples

Bump mapping

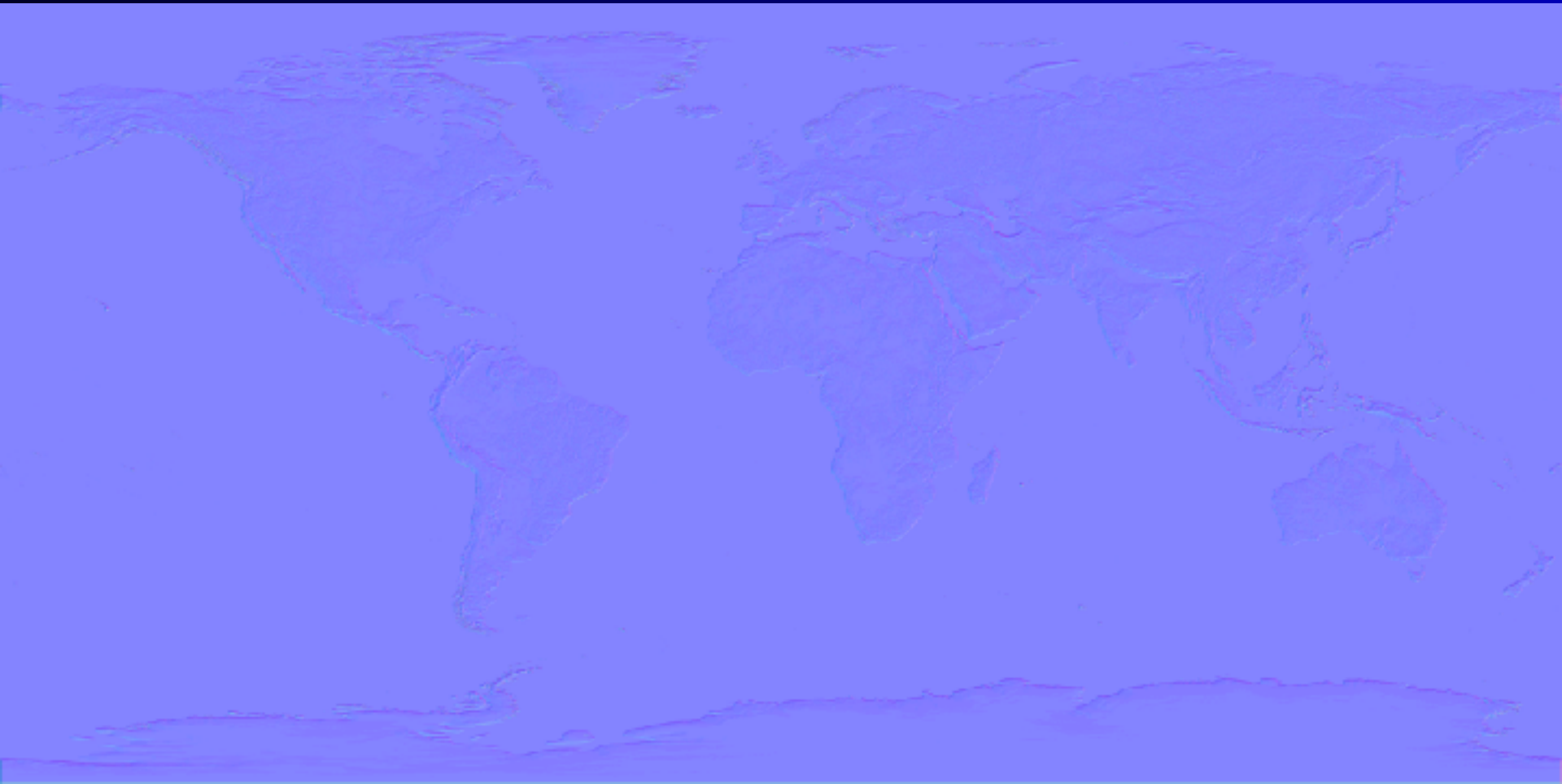
- Input = normal map *(nx, ny, nz)*
- Local frame:
  - *z* = geometric normal
  - *x,y* = tangent, bitangent



Follow the texture coordinates!

Bump mapping

- Example : note how blue (*z*) is dominant

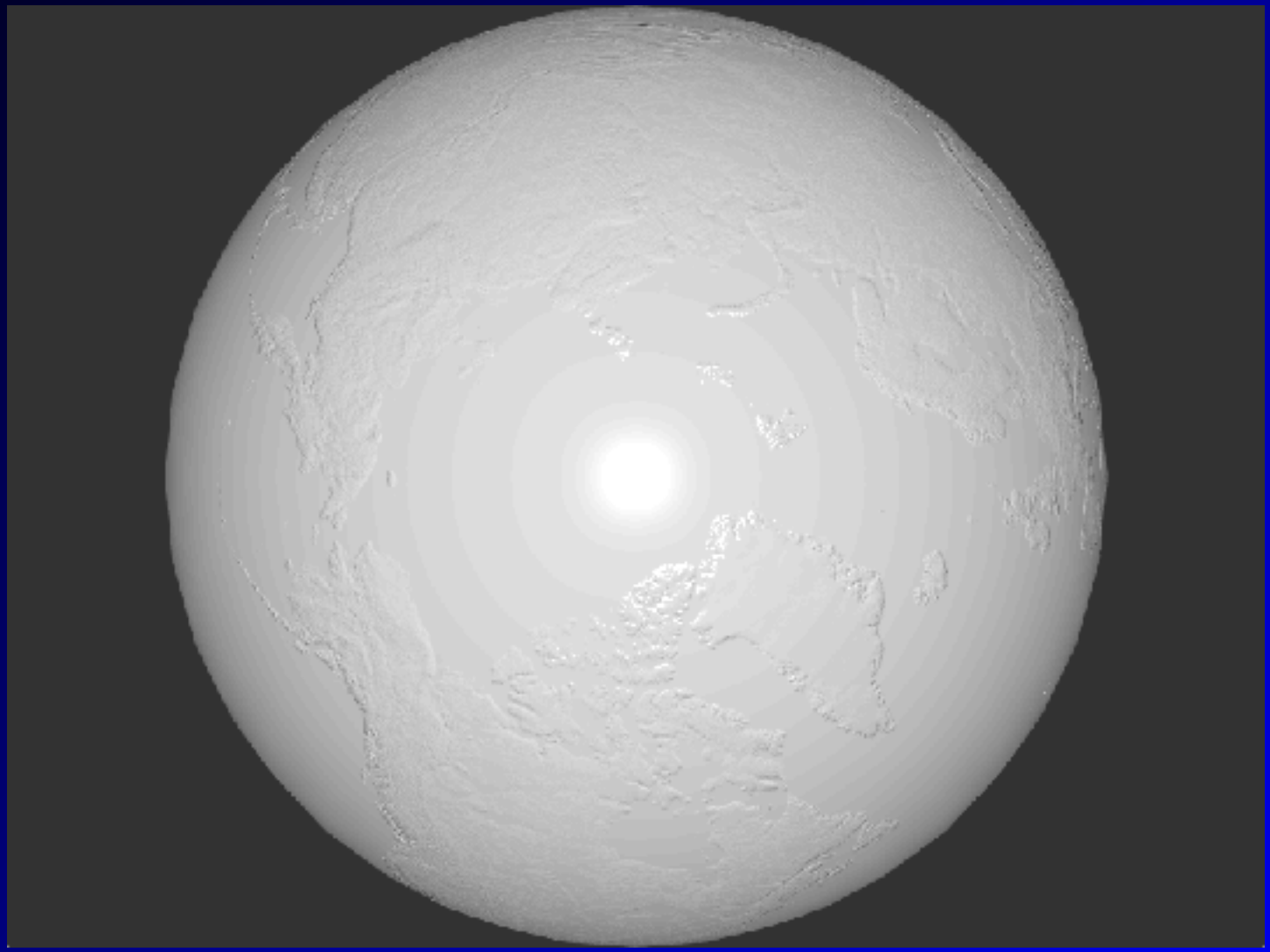


Bump mapping

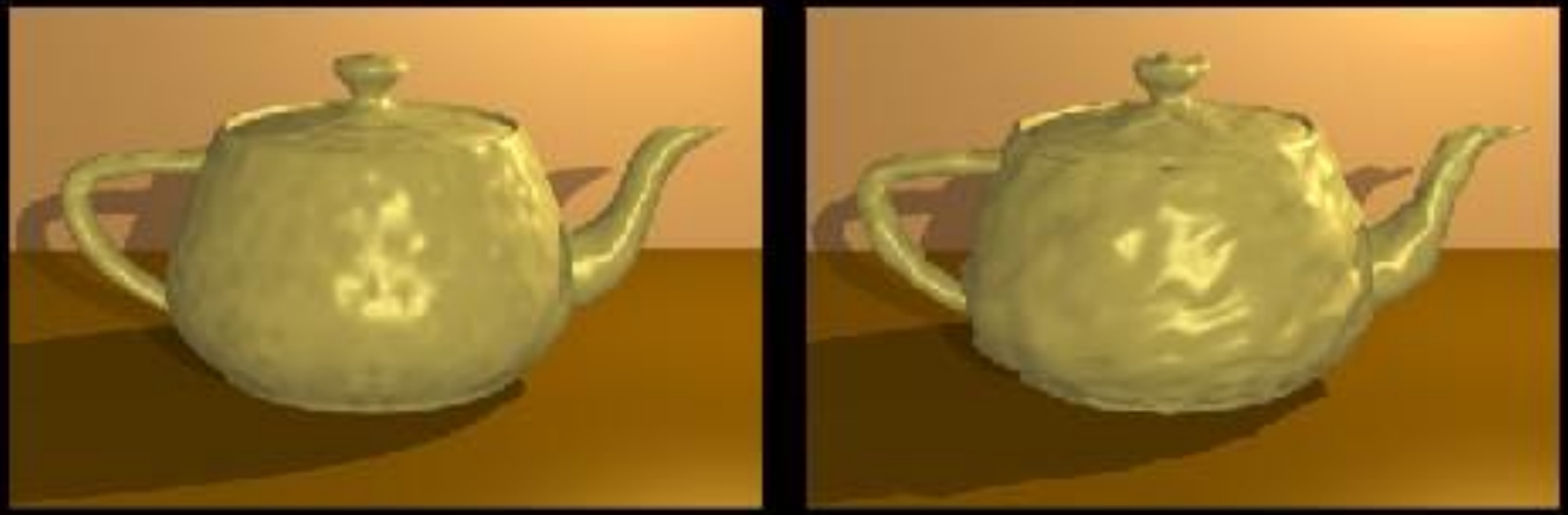
- Shading normal : local frame
- Light, eye: global frame
- Move everything to the same frame
- [TBN]: transformation matrix
  - To inverse, or not to inverse?

- Note:
  - textures in $[0,1]^3$
  - normals in $[-1,1]^3$

Bump mapping



Displacement mapping



Displacement mapping: how?

- Not in the fragment shader
  - Except towards the inside?
  - Candidate for tesselation shader

- Easier with other rendering methods
  - ray-tracing

Relief textures

- displacement mapping extreme case

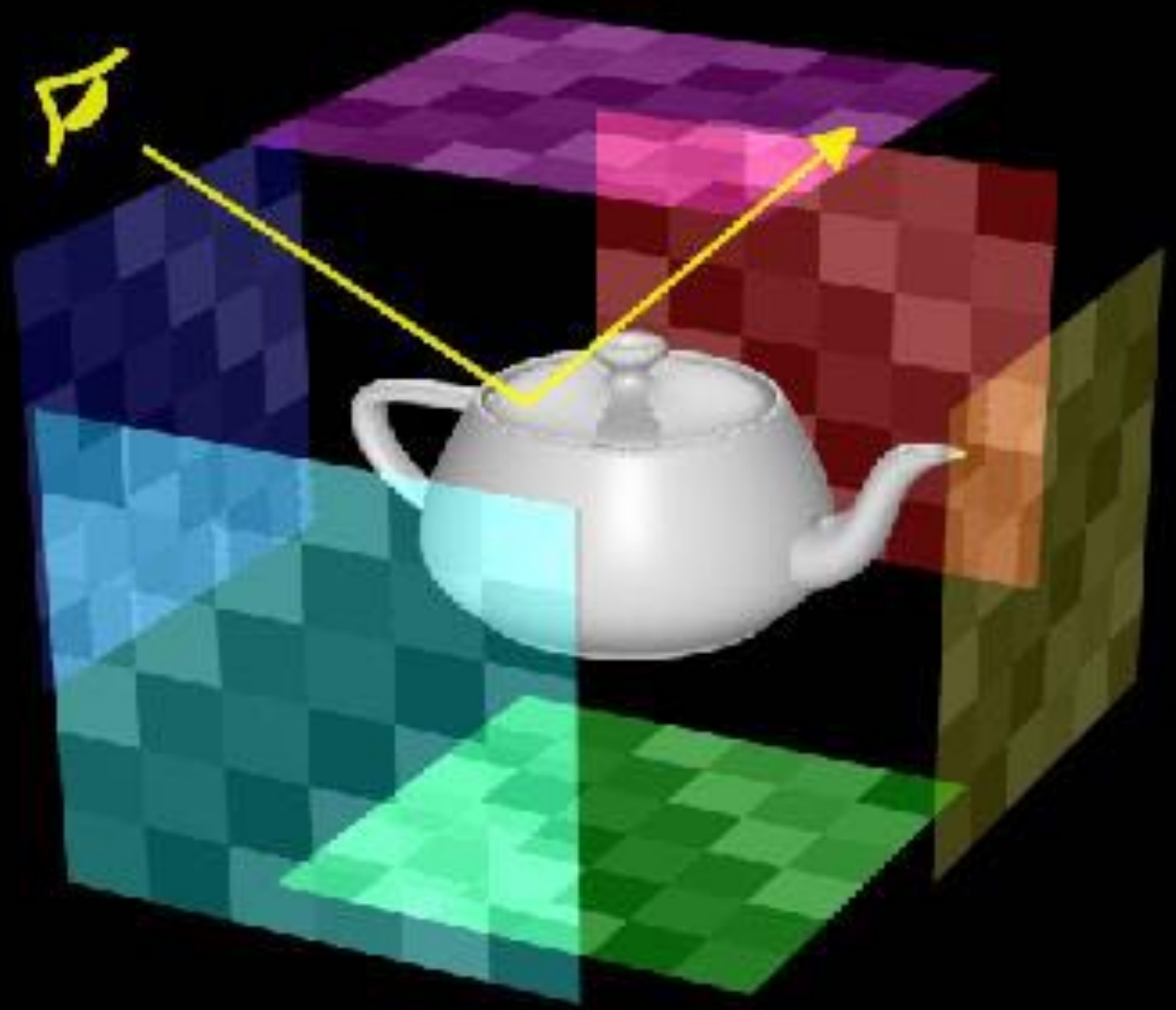
Relief textures

- How?
- Warp textures before mapping

- Or follow rays in a height field

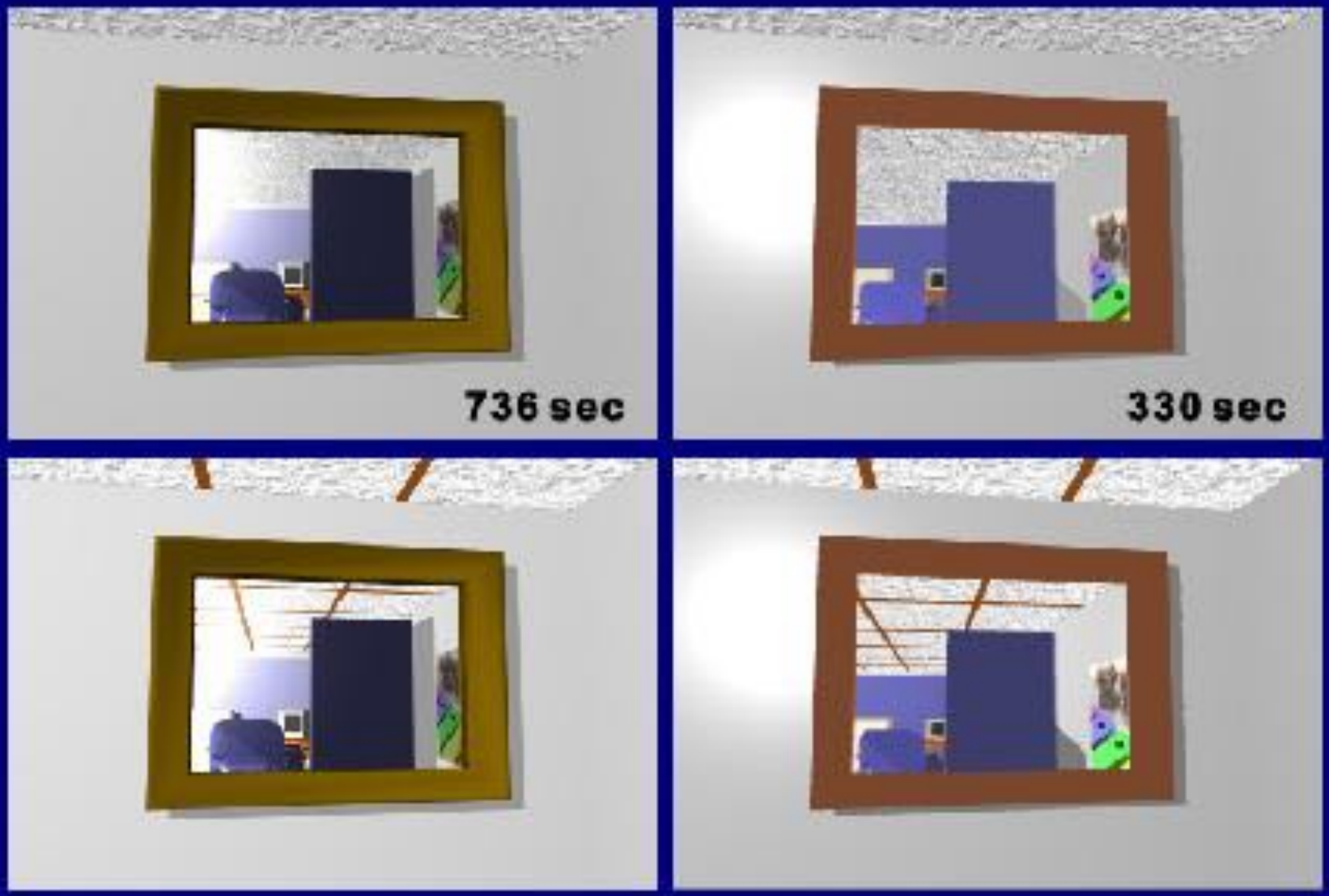
- Polygons = convex hull

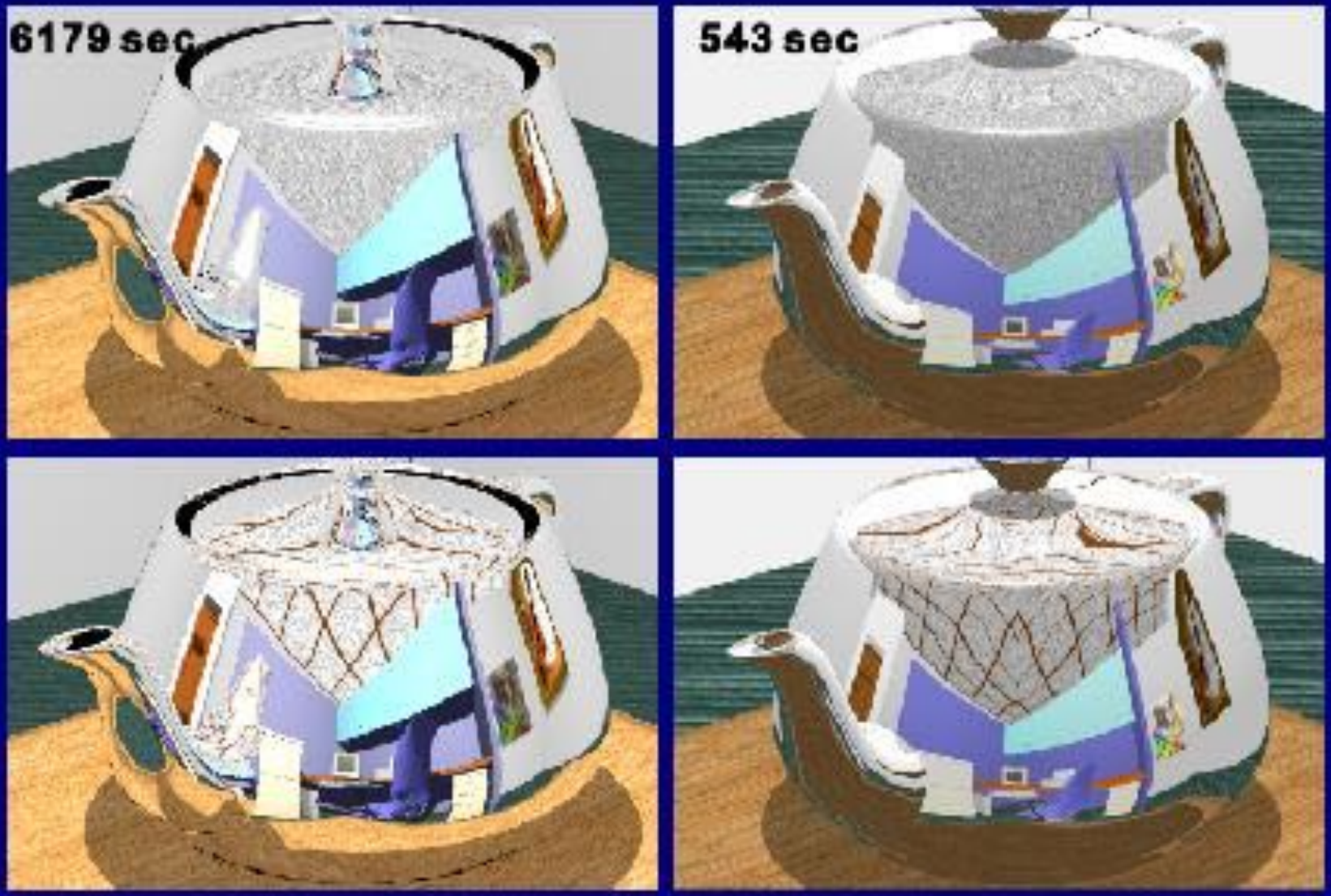
Environment mapping



Raytracing/Env. mapping

Raytracing/Env. mapping



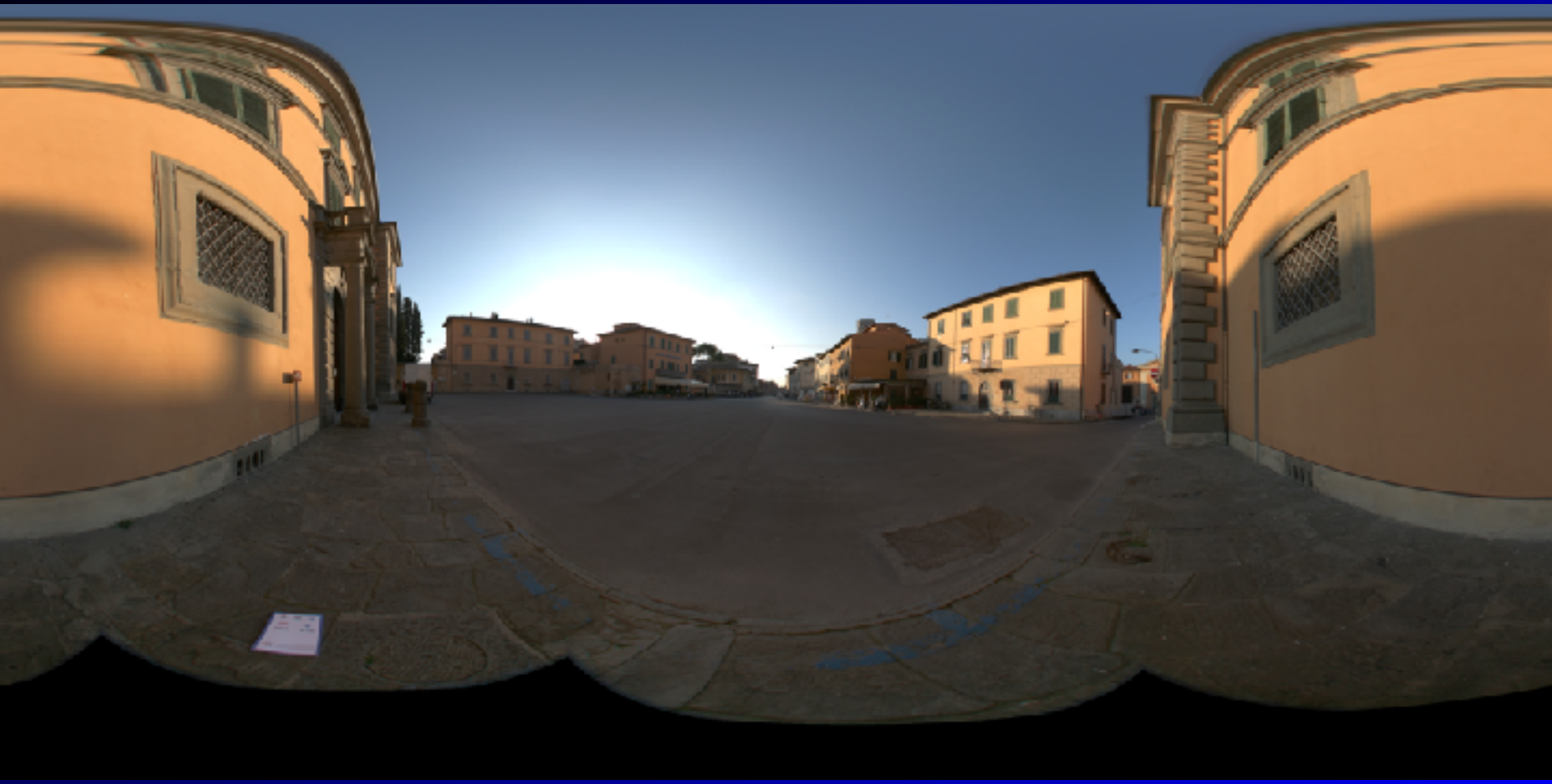

6179 sec
543 sec

Environment mapping

- Texture = distant light
- Parameterization: cube, sphere

- Incoming ray + reflection = outgoing ray
- Query texture in this direction

Environment mapping



Example environment map (spherical parameterization)

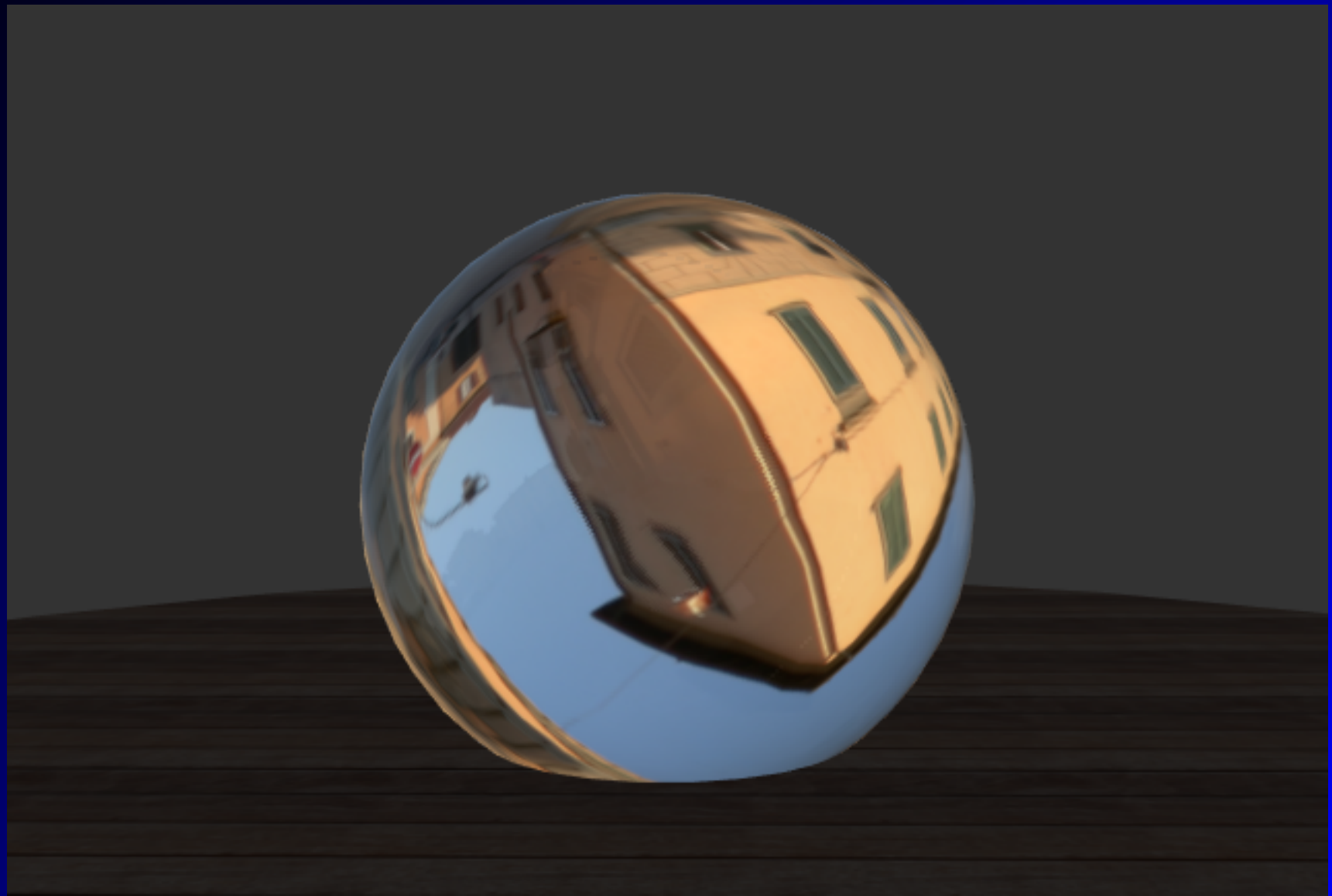
Environment mapping

Environment mapping

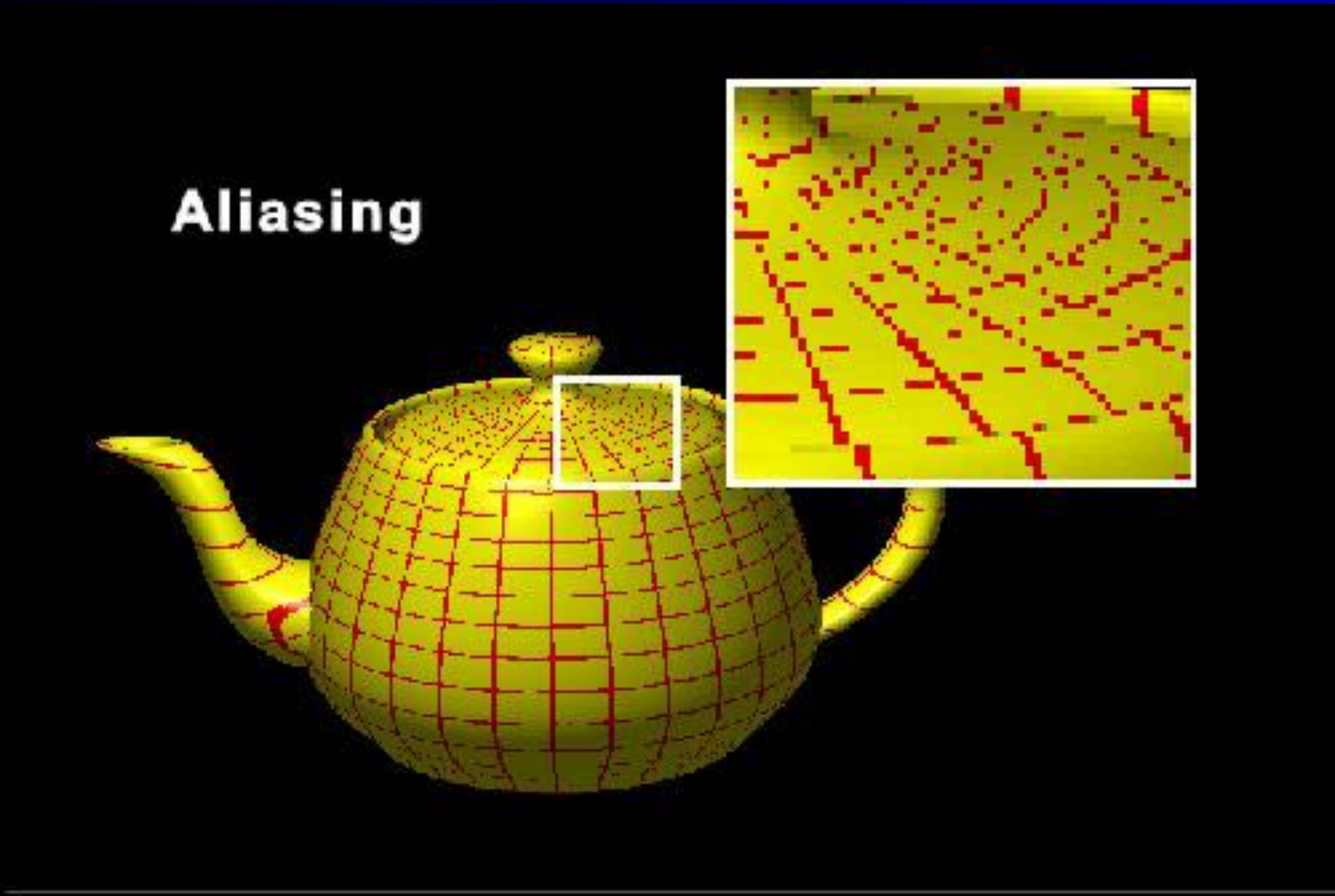
- Can also work with refracted rays
- Only one interface
  - huge approximation

Environment mapping

Environment mapping

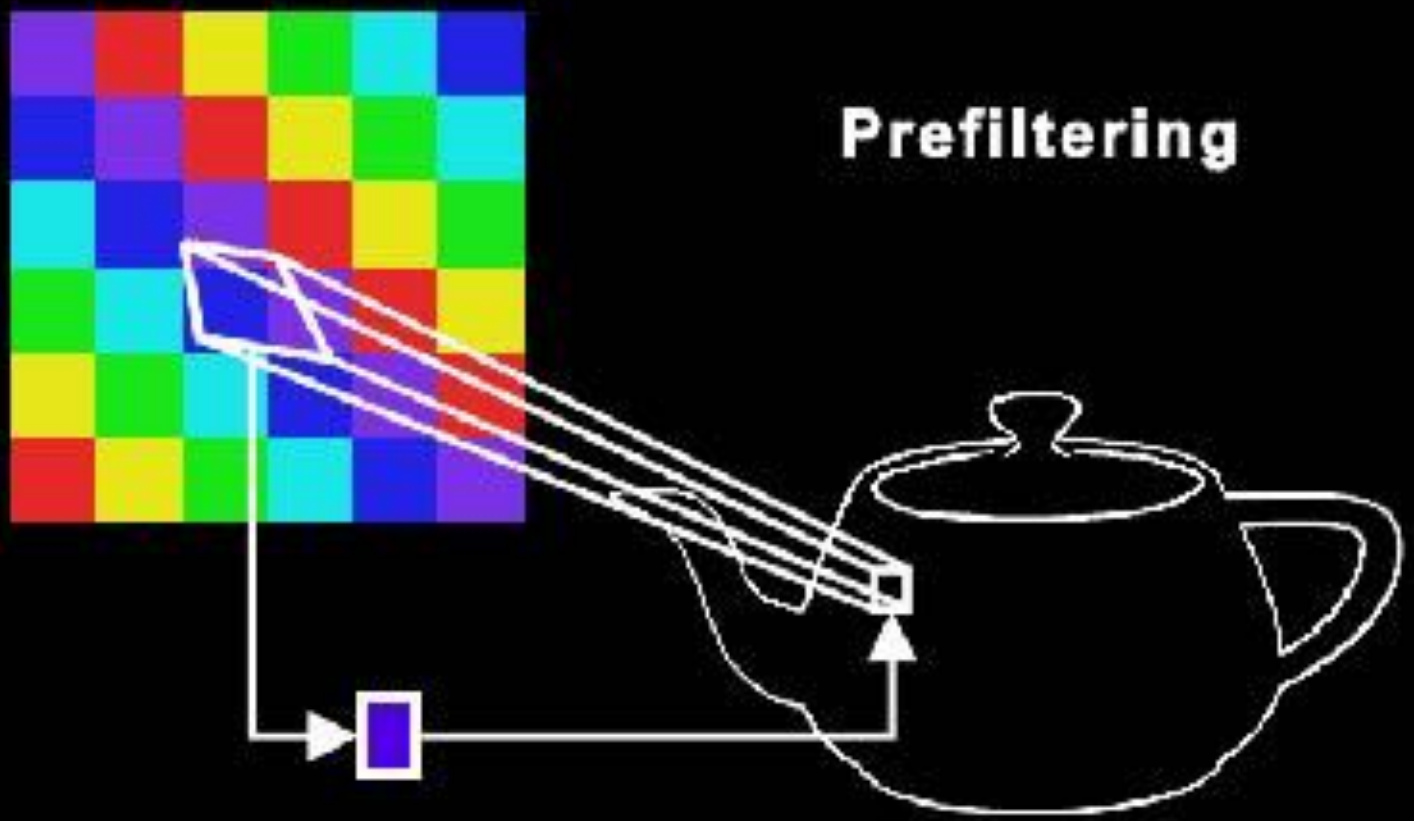


Aliasing

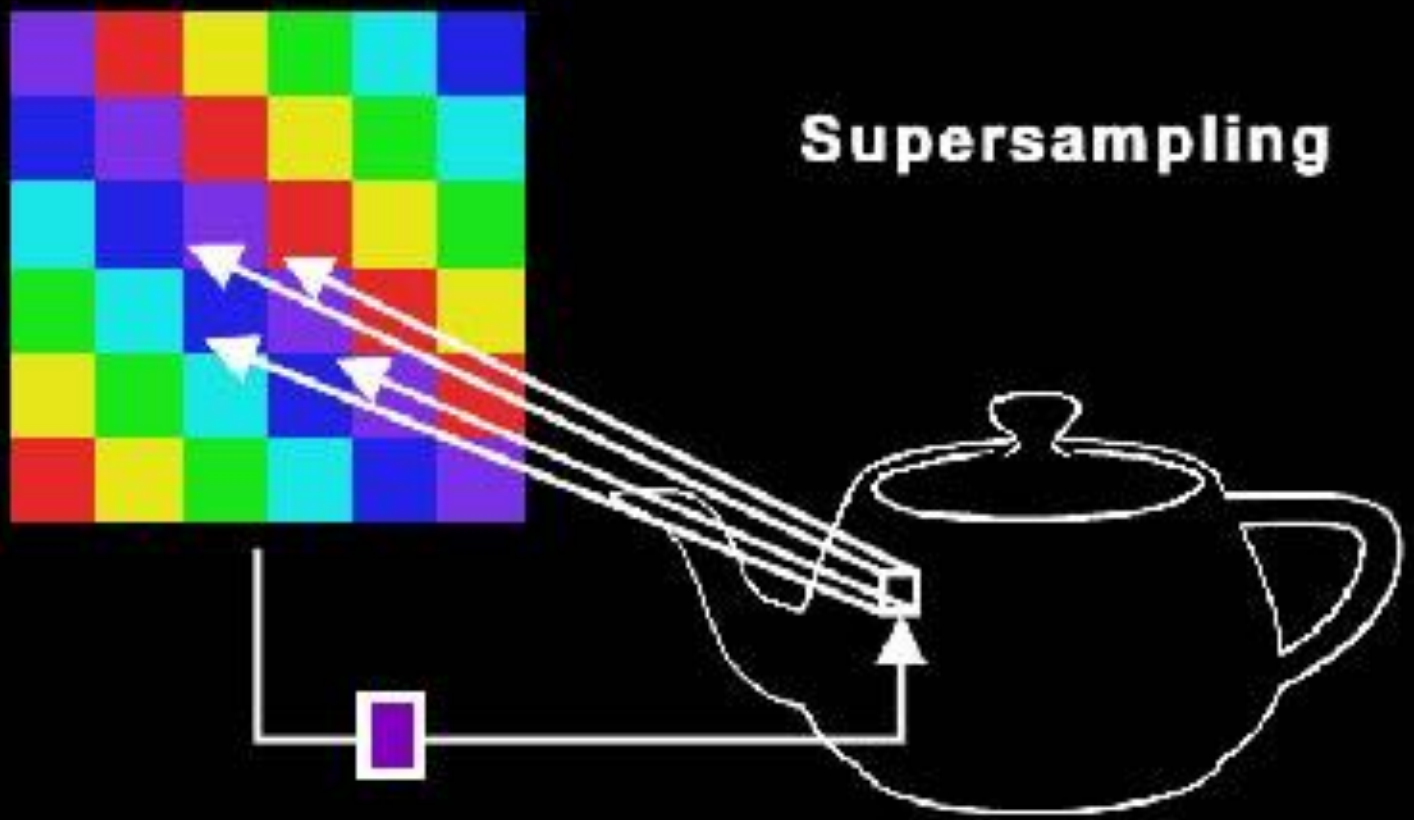


Under-sampling

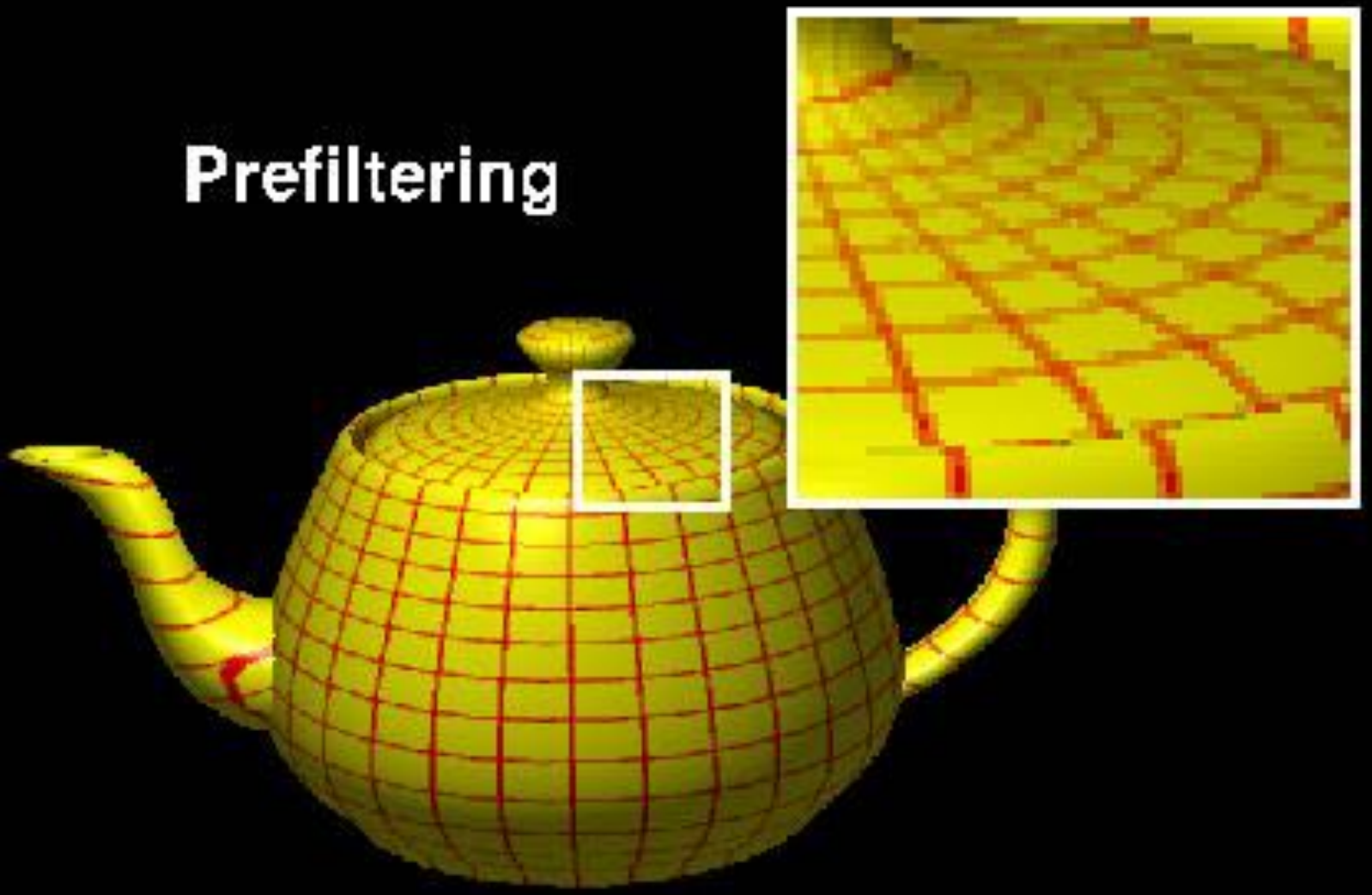
Need pre-filtering



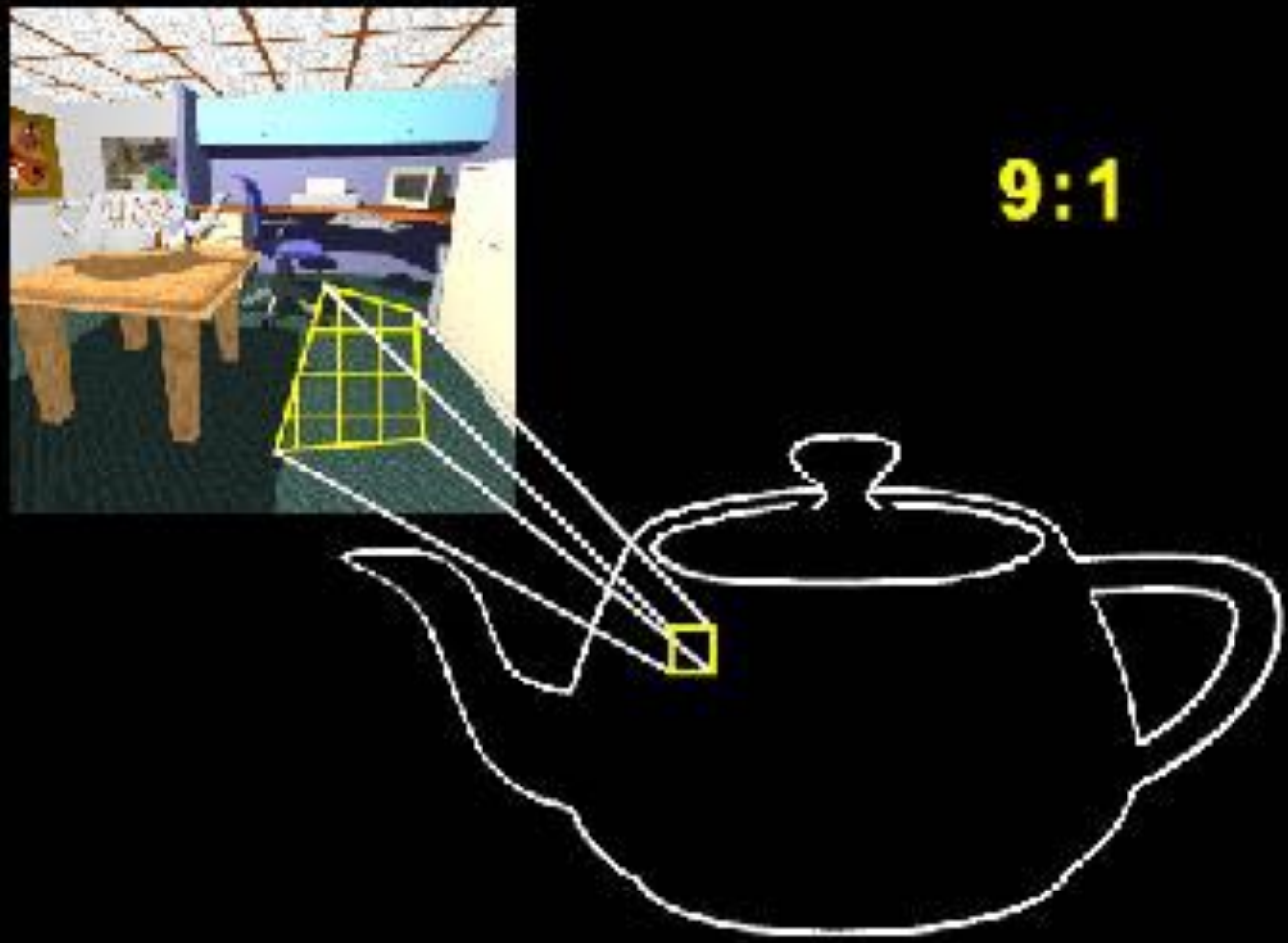
Multiple samples per pixel

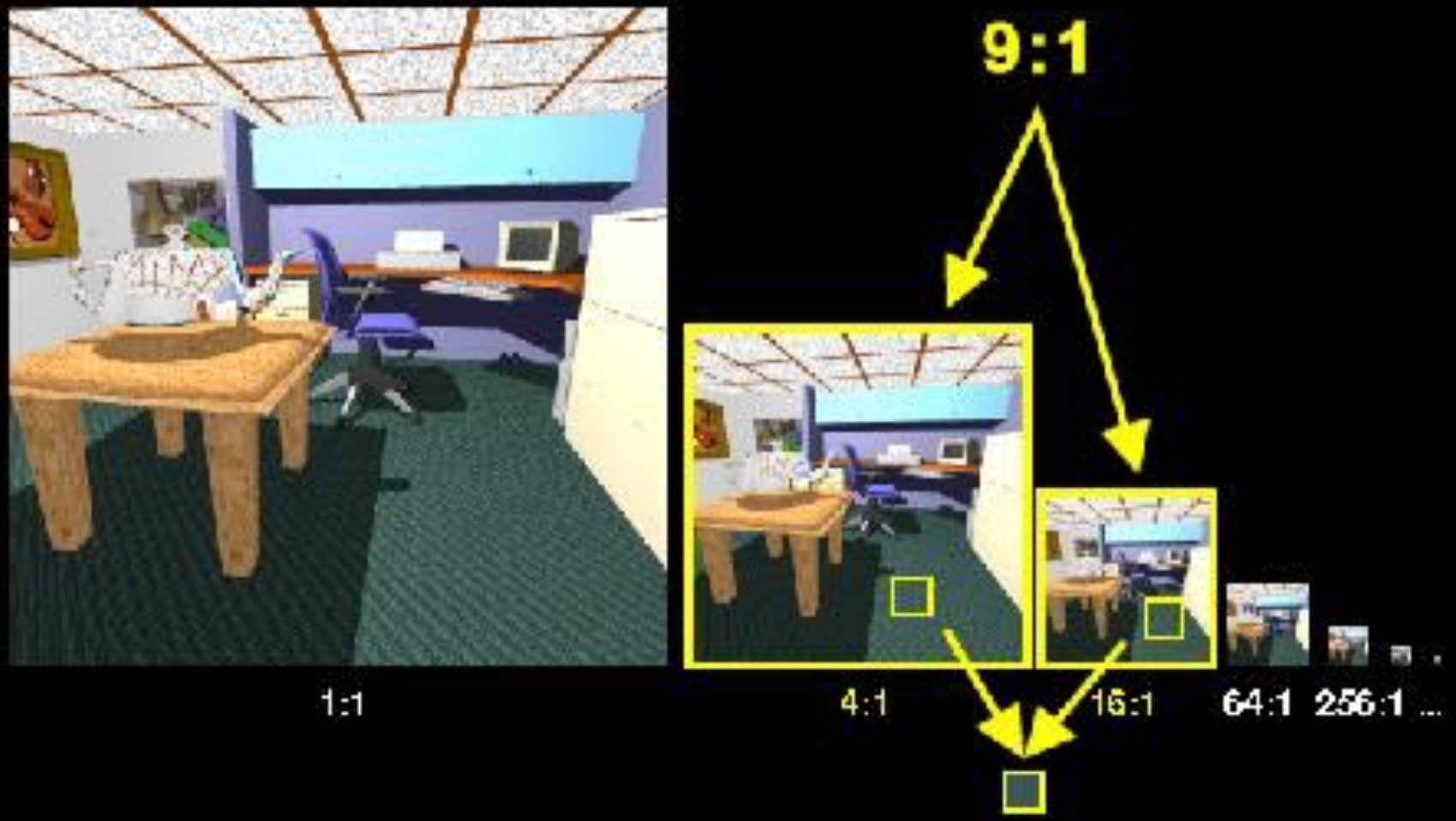


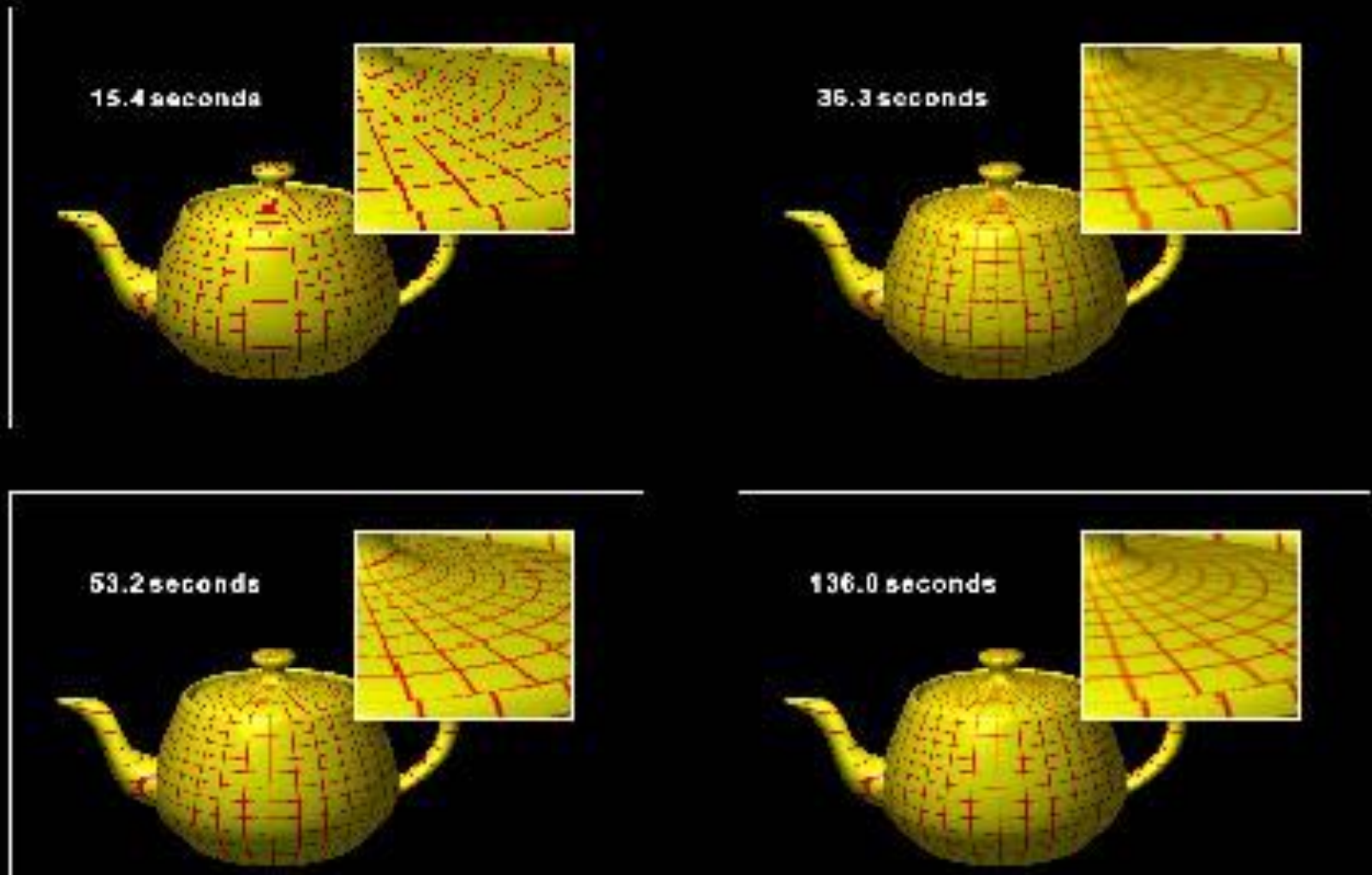
Prefiltering



Mipmaps


9:1


9:1
1:1
4:1
16:1
64:1
256:1 ...


15.4 seconds
36.3 seconds
53.2 seconds
136.0 seconds

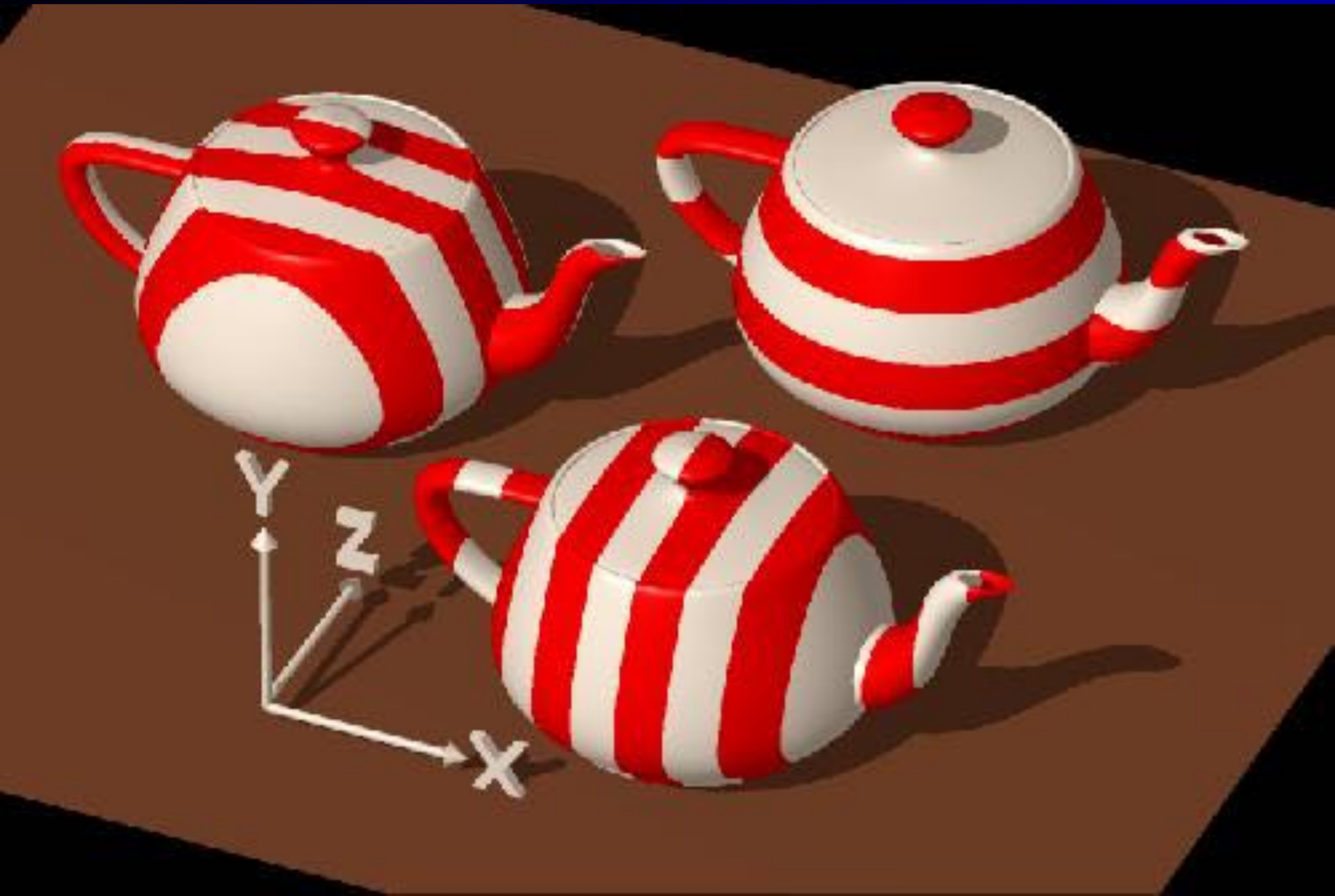
Aliasing

- Texture + distance = aliasing
  - Looks bad
  - Multi-sampling is not enough
- Color textures: can pre-filter
- Normal maps, height maps:
  - Pre-filtering doesn't make sense
  - Open research problem

3d textures

3D parameterization

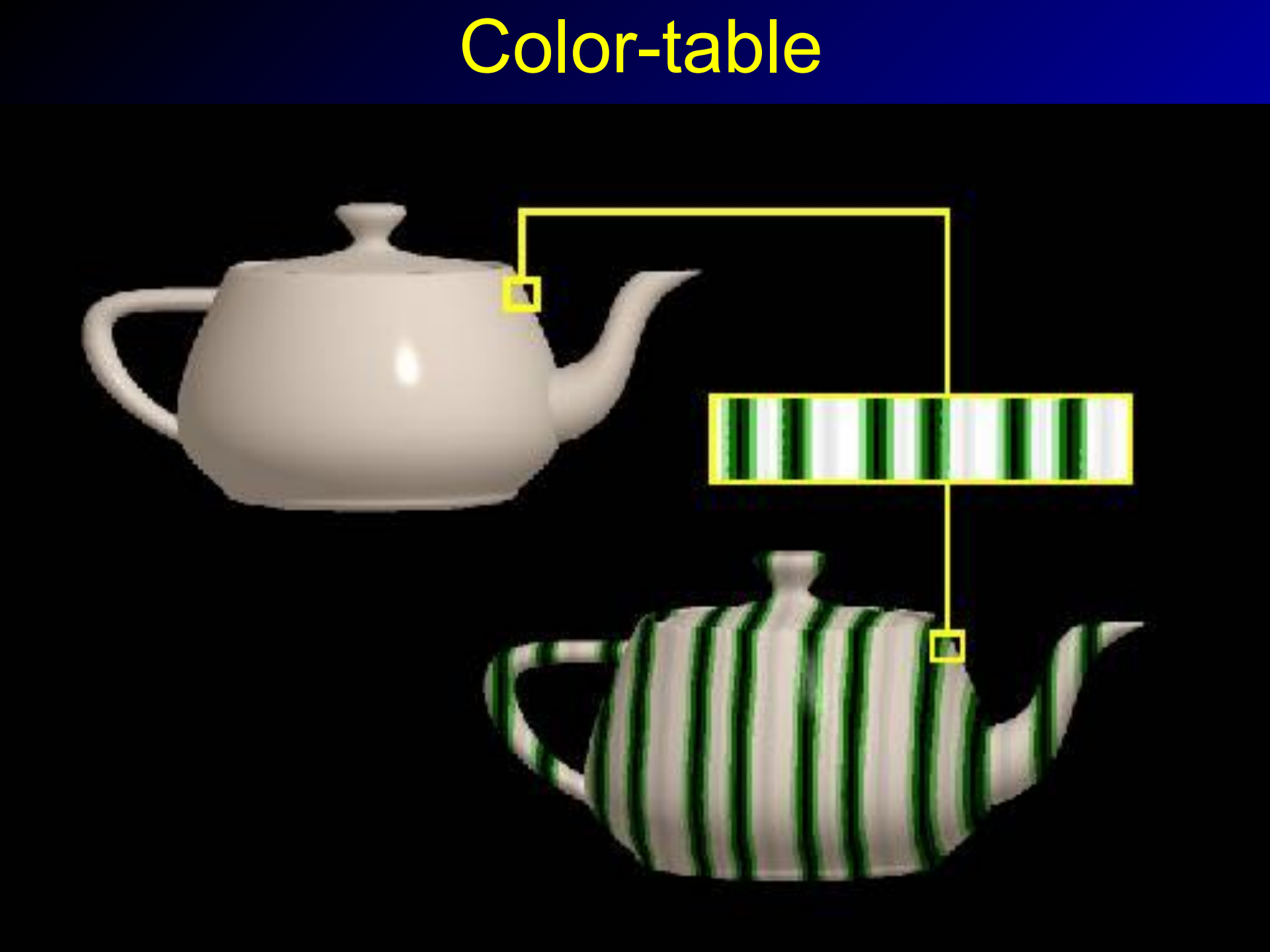
Examples: distance to a plane



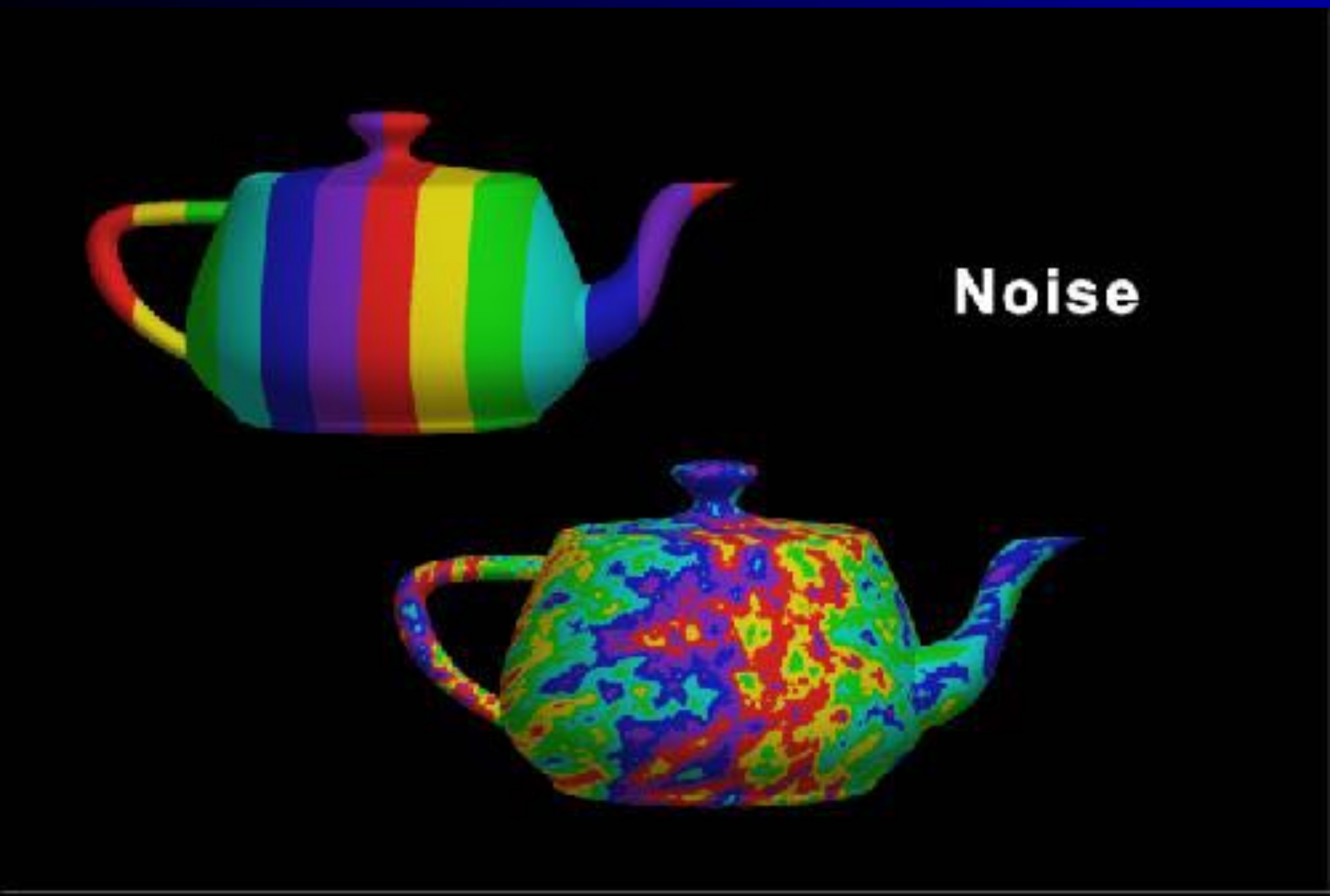
Distance to a line

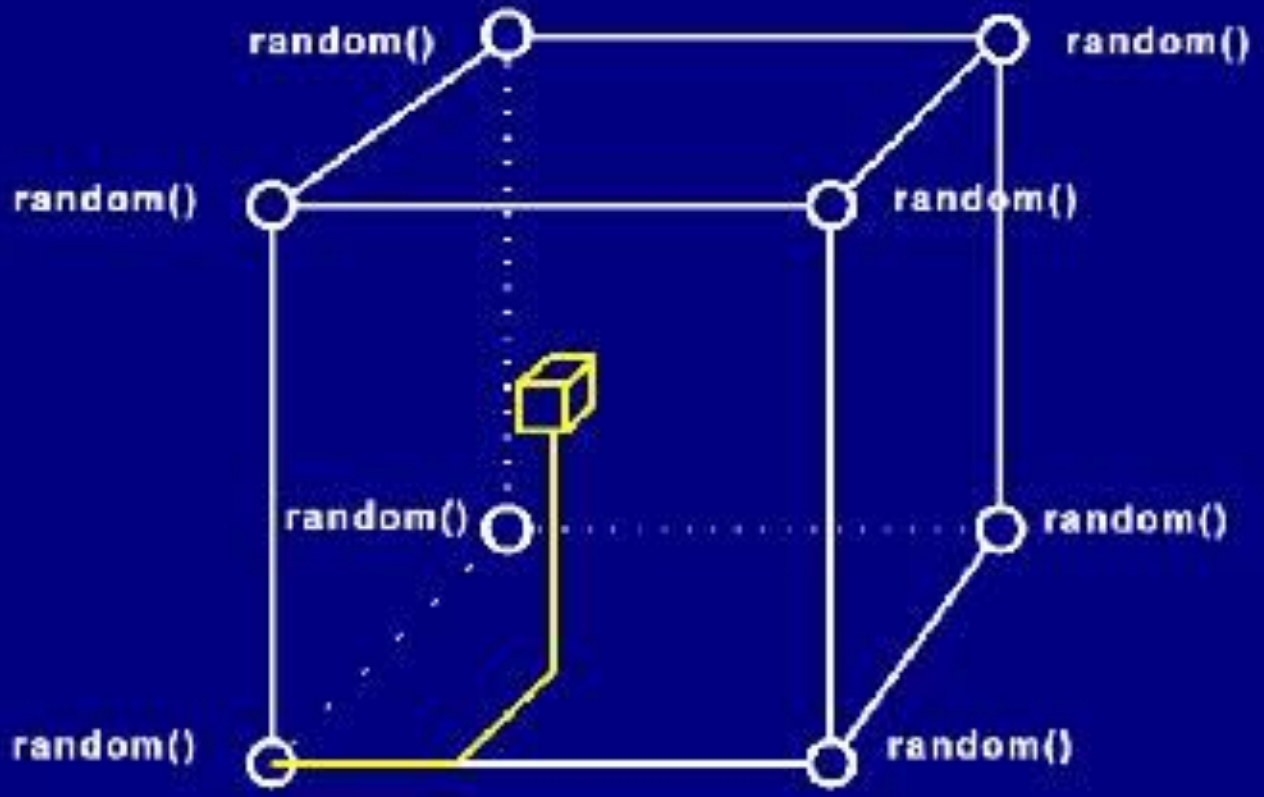
Color ramps, sinus…

Color-table

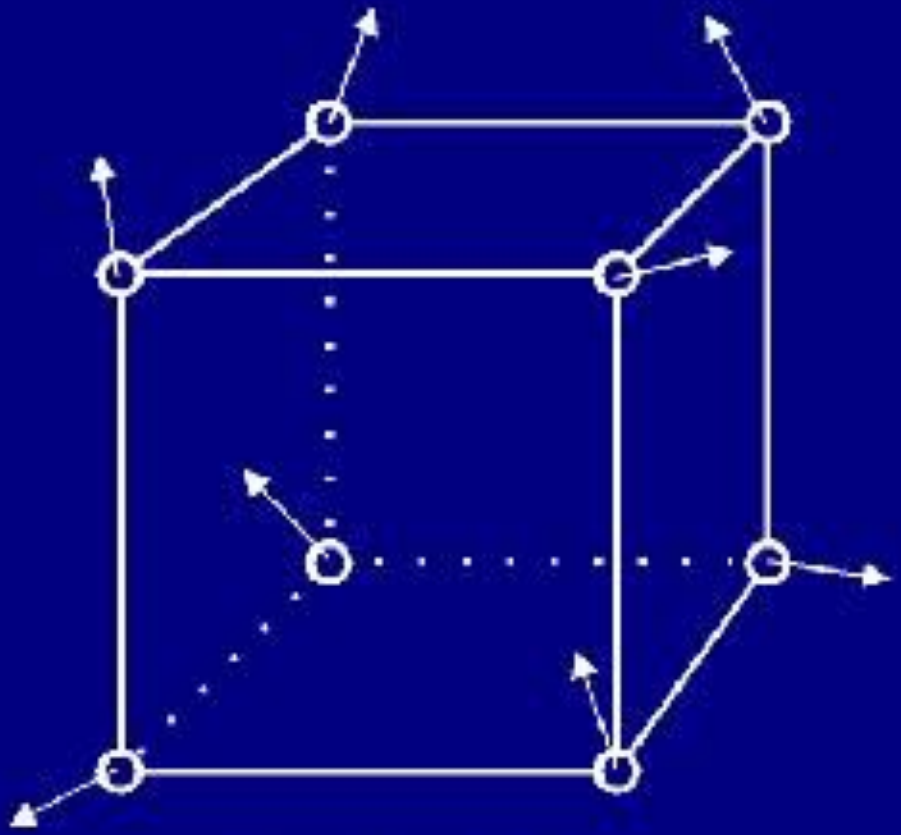


Noise is useful



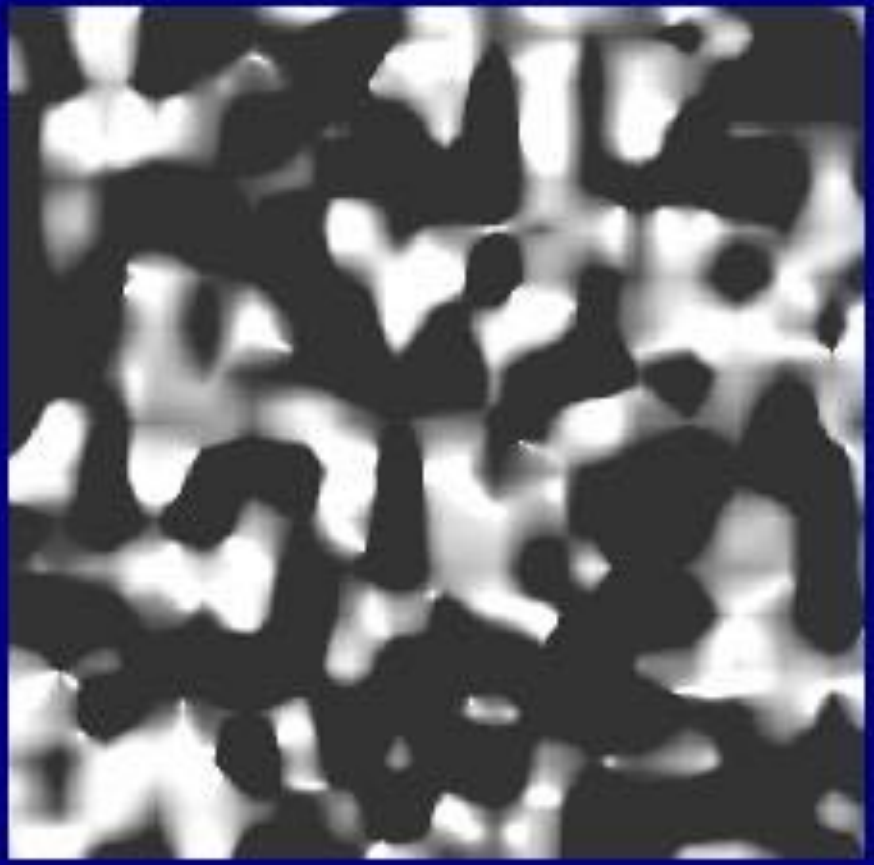


lattice noise



gradient noise

lattice



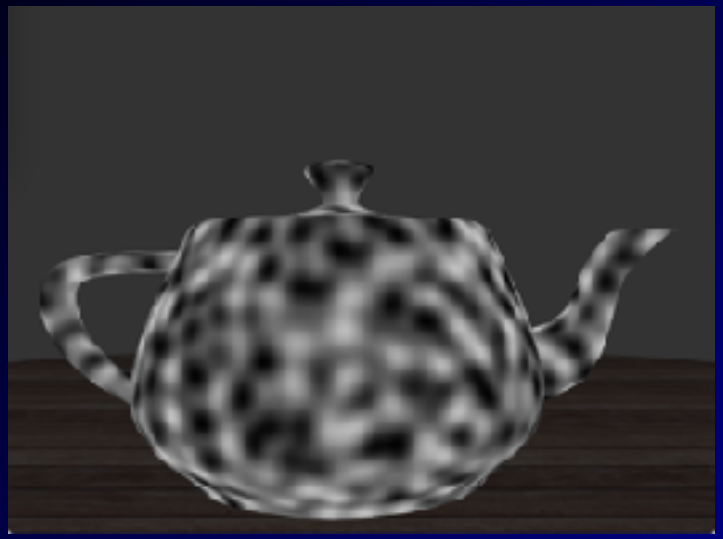
gradient

Simplex noise

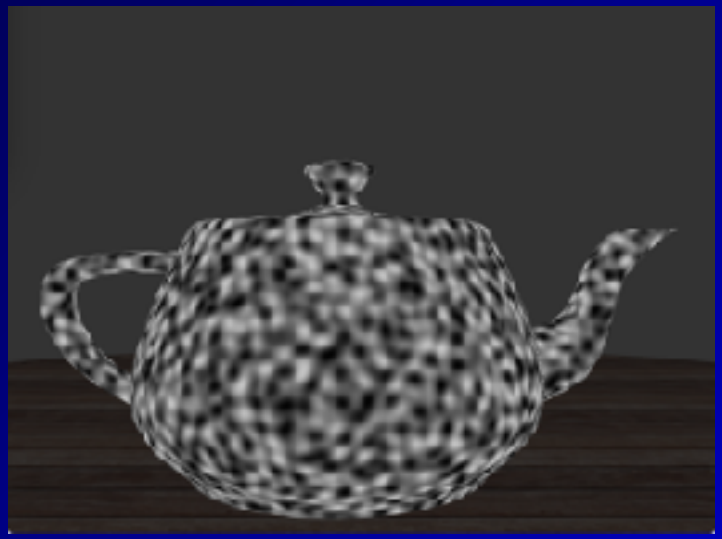
- Same as gradient noise
- Use a simplex instead of a cube
- 3D: tetrahedron + gradient interpolation
- Underlying structure is invisible

http://en.wikipedia.org/wiki/Simplex_noise

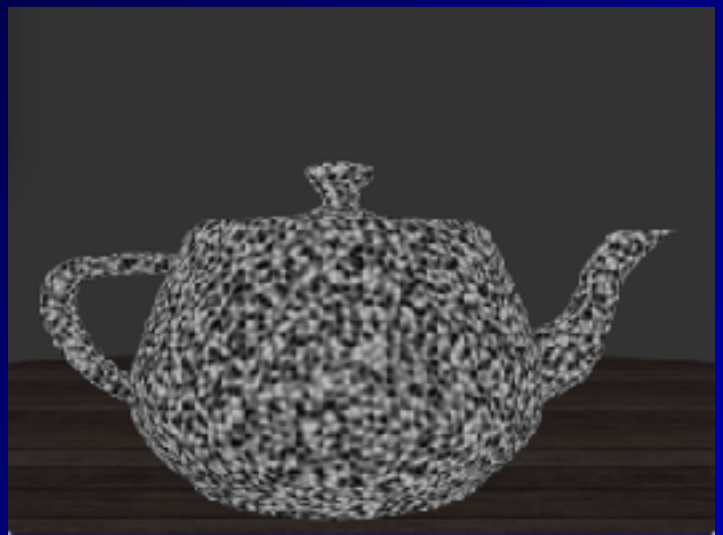
Frequency



8

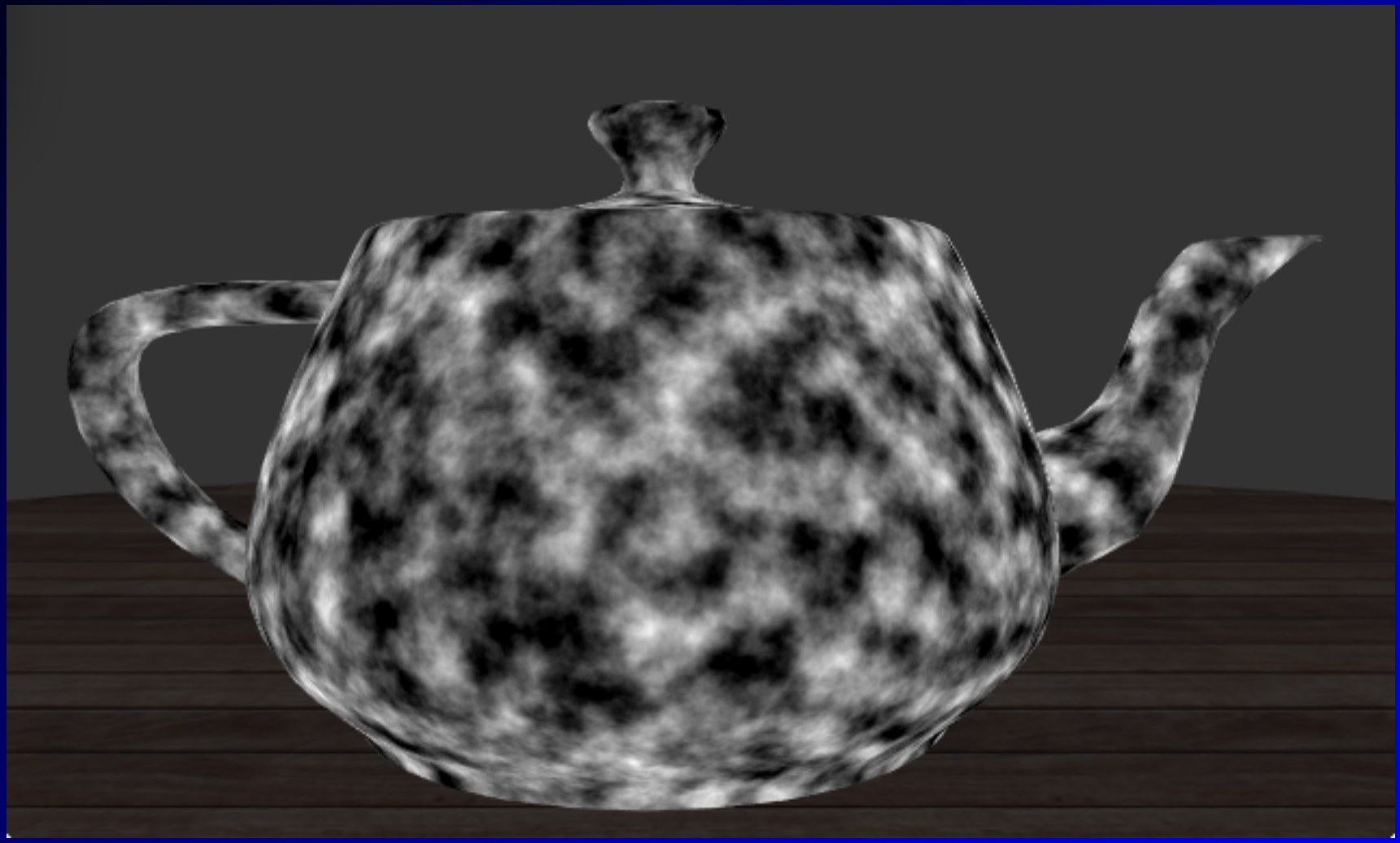


16



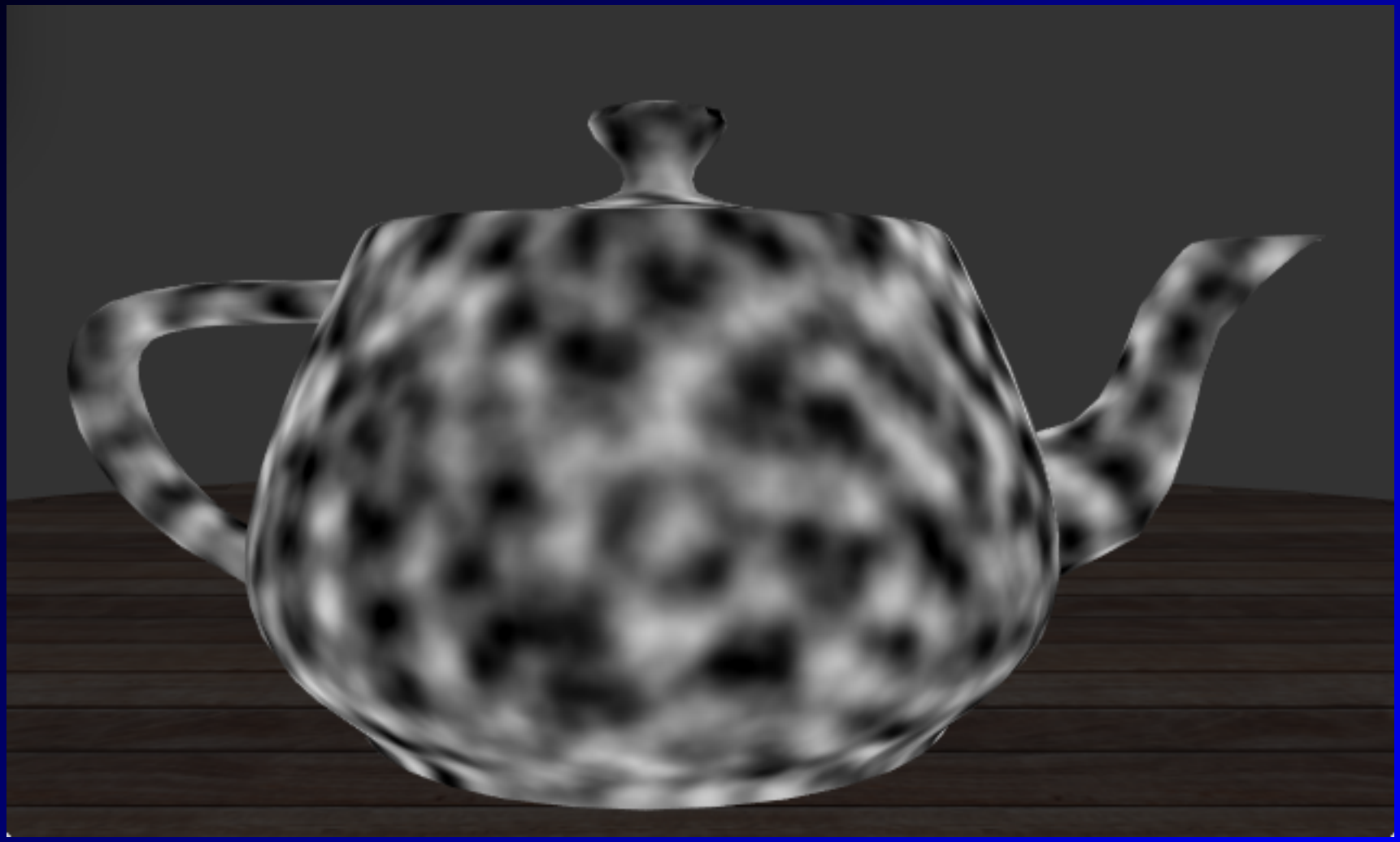
32

5 octaves together



Persistence = 0.5

5 octaves together



Persistence = 0.2

Noise

- Parameters :
  - Number of octaves
  - Amplitude of first octave
  - Persistence: ratio amplitude octaves
    - Geometric sequence
  - Lacunarity: ratio of octave periods

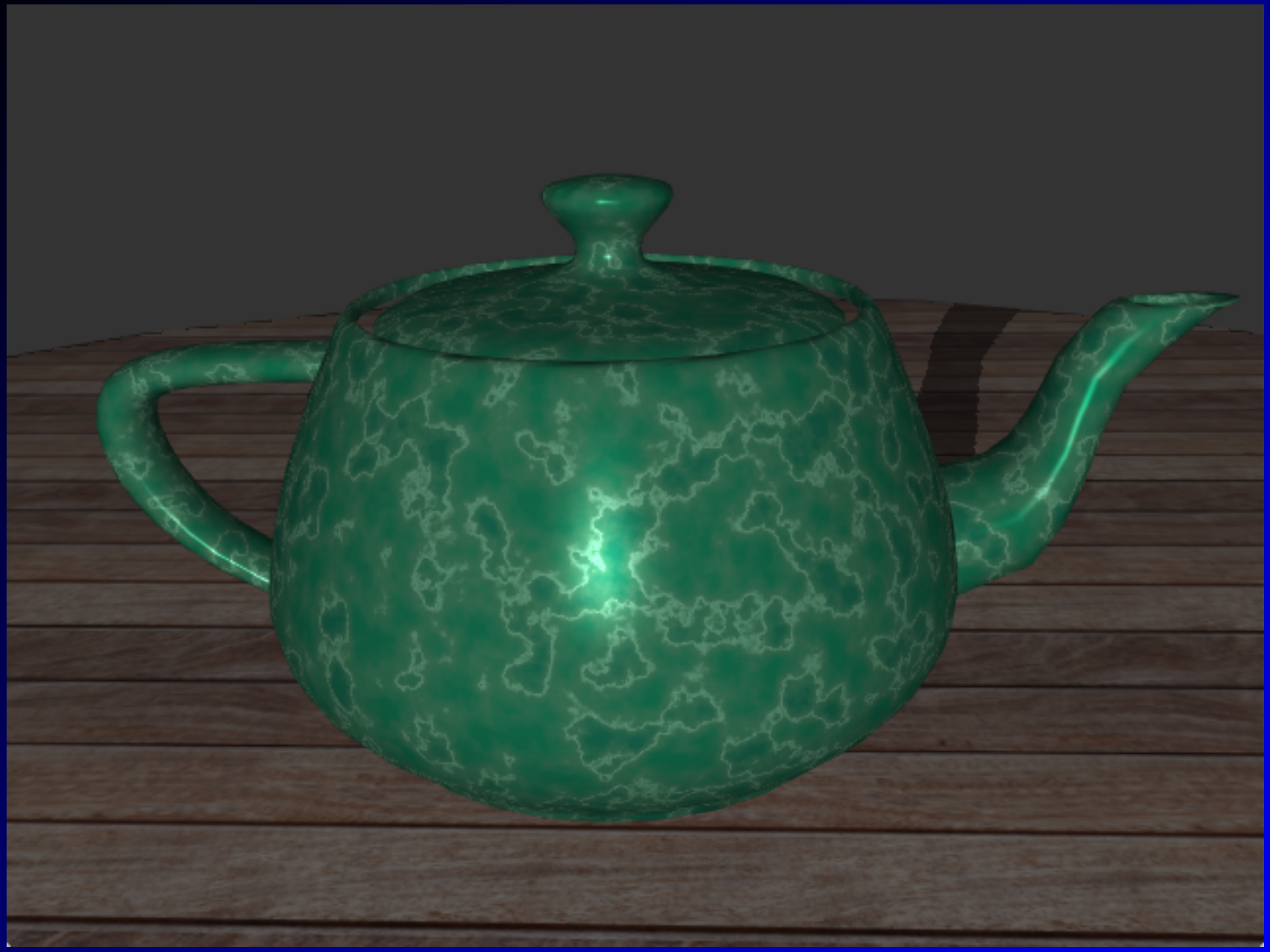
Noise

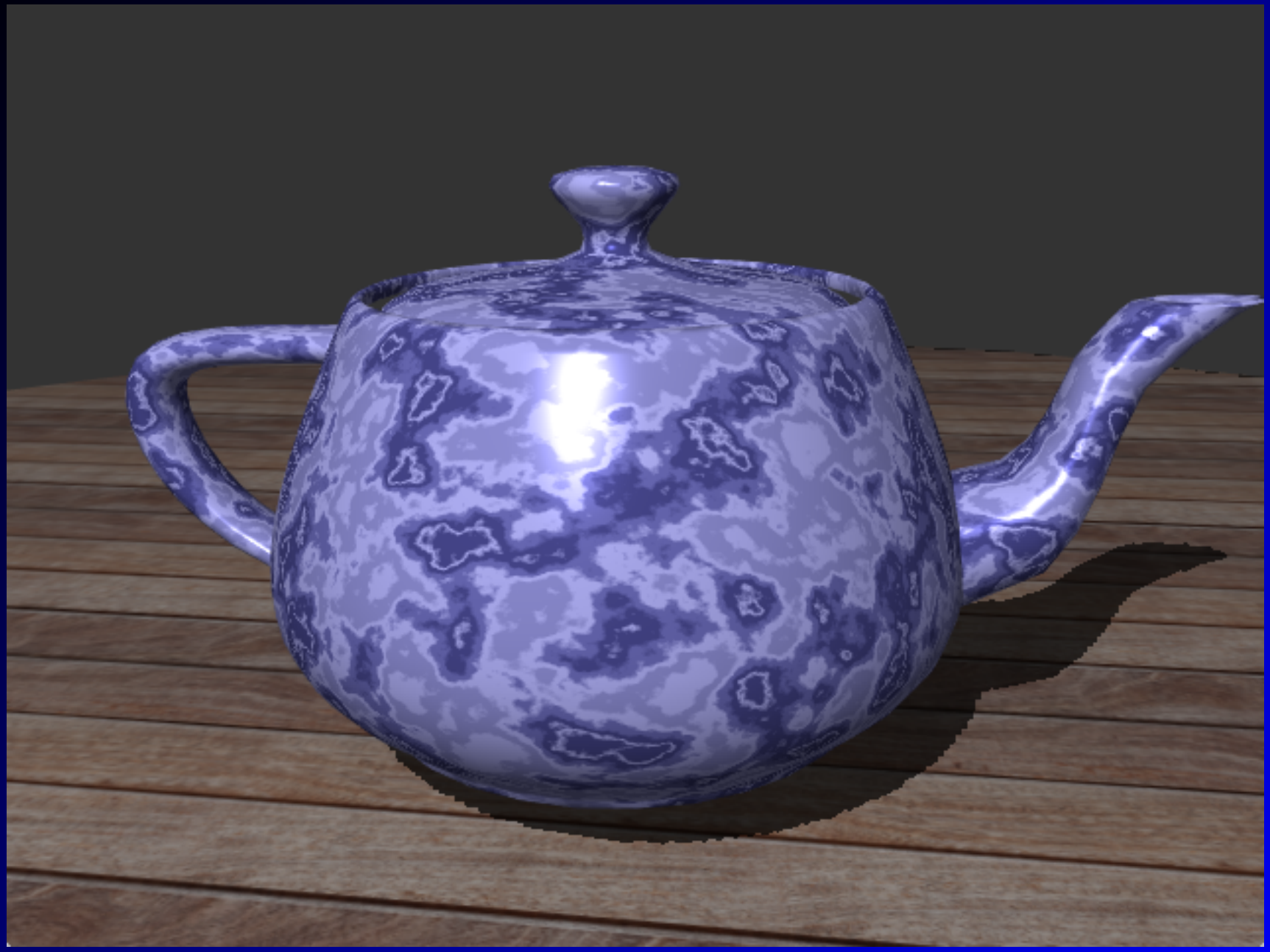
- Often compared to salt in cooking
- Only noise: not very good
- 3D textures without noise: a bit bland

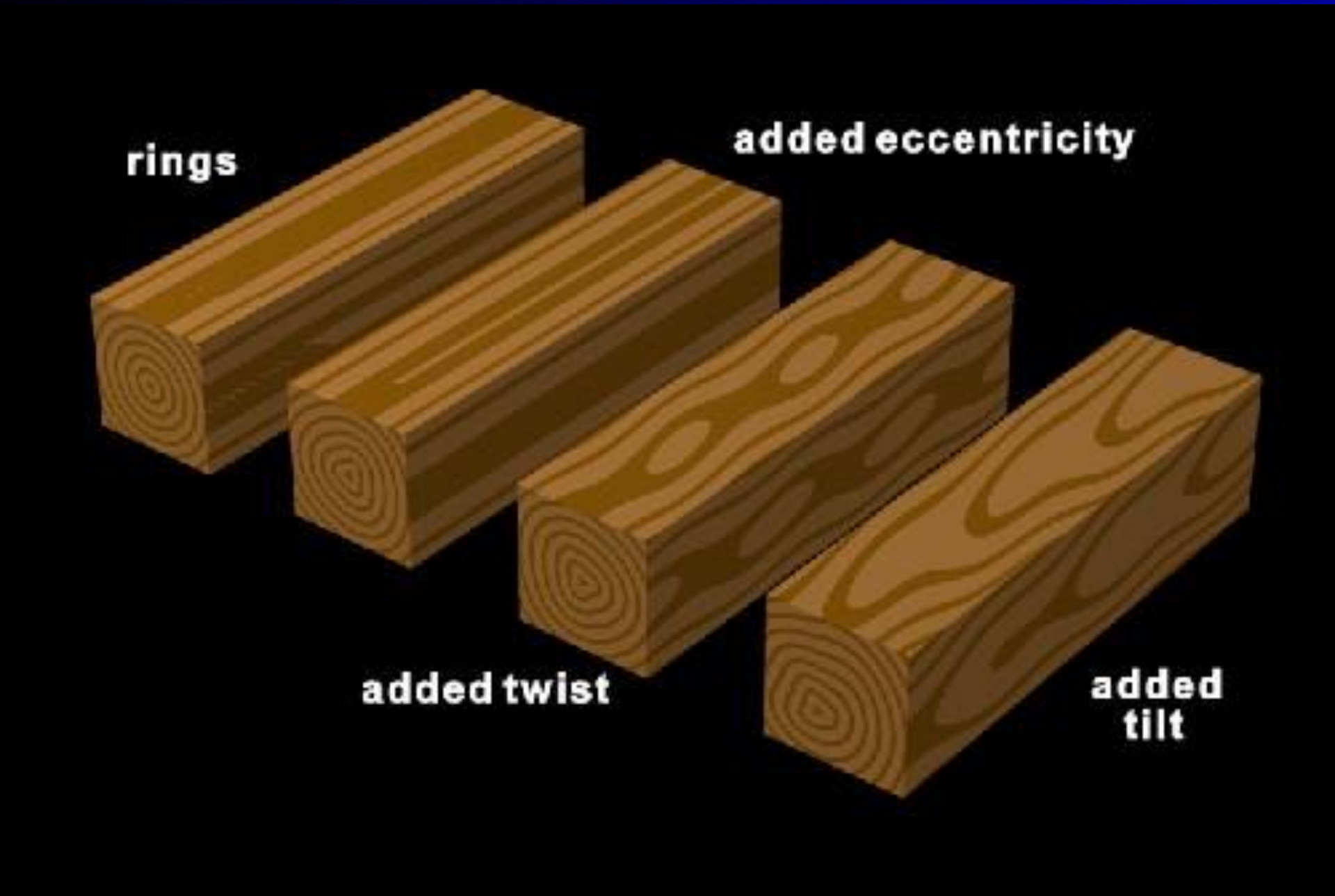
- Combination textures 3D + noise
  - Really interesting

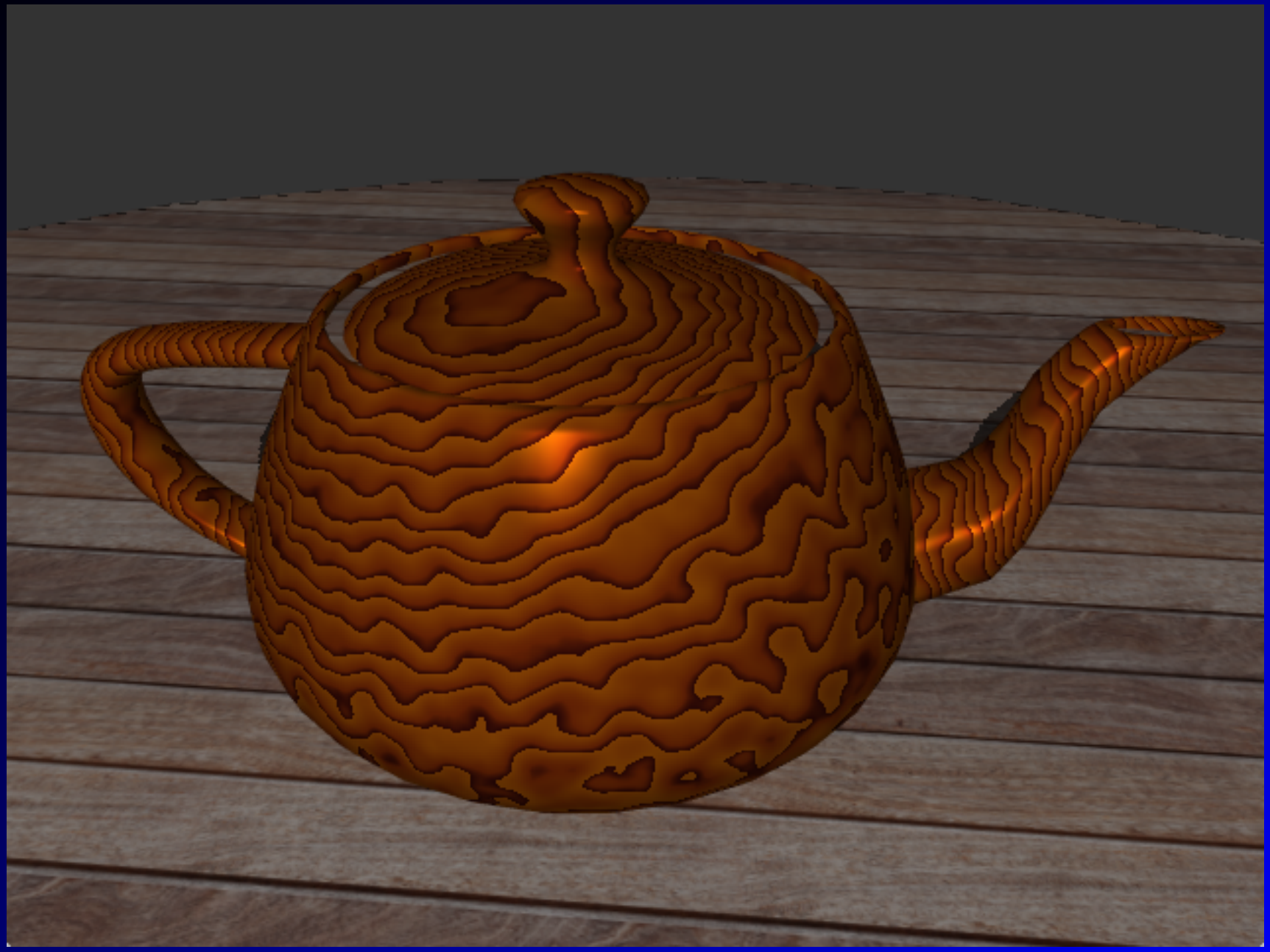
Procedural textures

Perturbations






rings
added eccentricity
added twist
added
tilt



Procedural textures + noise

- Not limited to color
- Normals, material parameters...
- Regular structure + a bit of noise
  - Wood, bricks, floor tiles...

- Filtering / anti-aliasing : harder, but necessary

Procedural textures for object definition

All together...