

Symmetry

CSCI 4229/5229

Computer Graphics

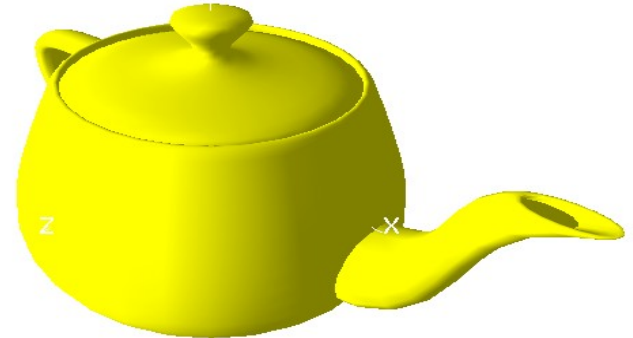
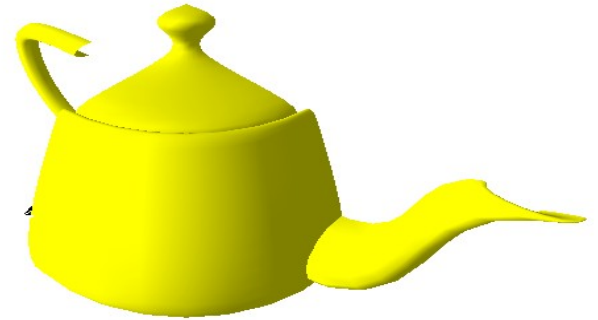
Fall 2026

Symmetry is widespread.

- Bilateral (left-right) symmetry
 - Animals (at least externally)
 - Cars, airplanes, boats
 - Fractals
- Axis-symmetrical symmetry
 - Symmetric with respect to an axis
- Symmetry in rotation or translations

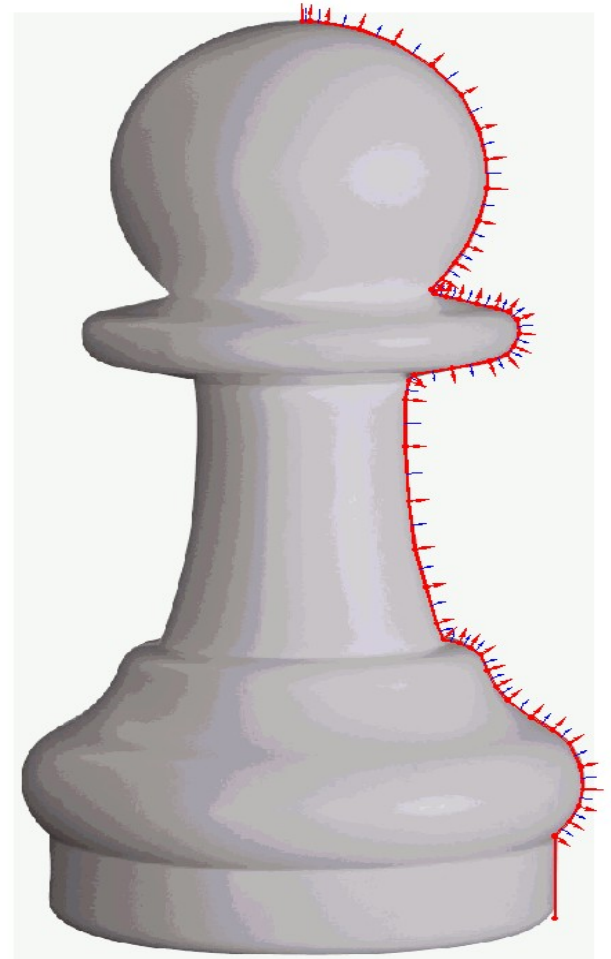
Advantages to symmetry

- You only need to figure out how to draw a fraction of the object
- Axis-symmetrical objects can be analyzed in 2D



Chess Pawn

- Axi-symmetric y-axis
- In 2D cross section
 - Digitize the outline
 - Compute normal for each facet (blue)
 - Compute average normal where facets join (red)
 - Gouraud average
- Rotate around y axis
 - $(\mathbf{x}, \mathbf{y}) \Rightarrow (\mathbf{x} \cos \theta, \mathbf{y}, \mathbf{x} \sin \theta)$



Gouraud Averaging

- Calculate point to point vectors in 2D and normalize
 - (dx, dy)
- Rotate 90 degrees in 2D
 - $(dx, dy) \Rightarrow (dy, -dx)$
- **Average and renormalize**
 - First and last point are special cases
- Rotate around y axis
 - $(x, y) \Rightarrow (x \cos \theta, y, x \sin \theta)$

