

# **Symmetry**

**CSCI 4229/5229**

**Computer Graphics**

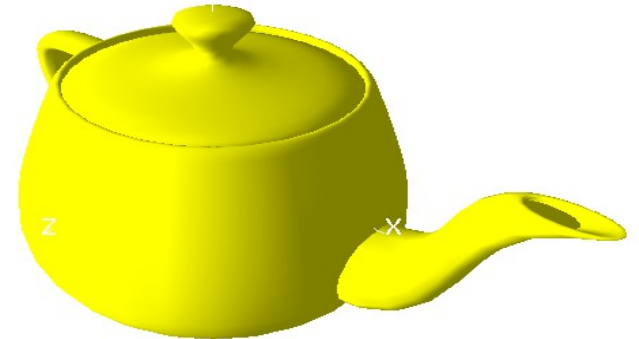
**Summer 2026**

# 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

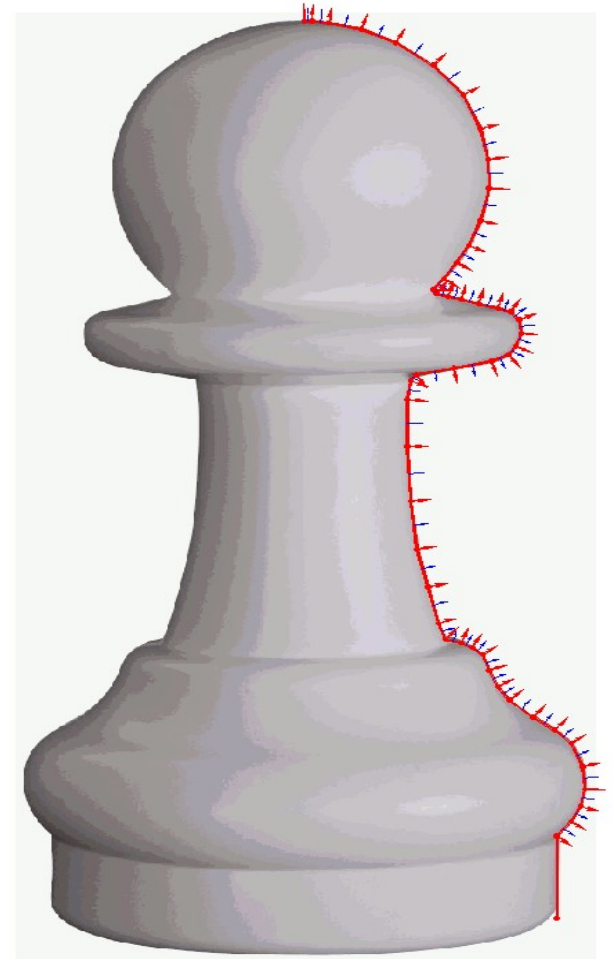
# Advantages to symmetry

- 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
  - $(\mathbf{x}, \mathbf{y}) \Rightarrow (\mathbf{x} \cos\theta, \mathbf{y}, \mathbf{x} \sin\theta)$

