

# **Polygons**

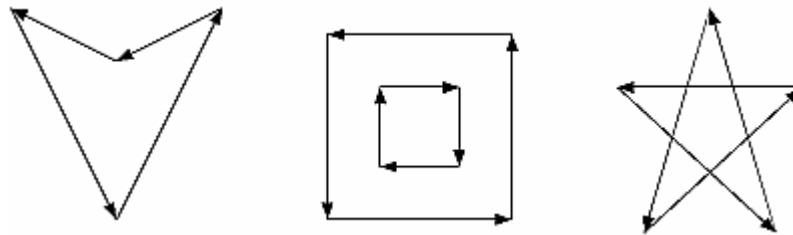
**CSCI 4229/5229**  
**Computer Graphics**  
**Fall 2020**

# Polygon Definitions

- A polygon is strictly a planar object
  - Plane defined as  $ax + by + cz = 1$ 
    - Three distinct  $(x,y,z)$  points
    - One  $(x,y,z)$  point and a normal vector
  - Finite subset of plane defined by set of vertices
  - Vertexes **must** be in the plane
- In OpenGL you can specify 3D vertices
  - When vertexes are not in a plane, the results are implementation dependent

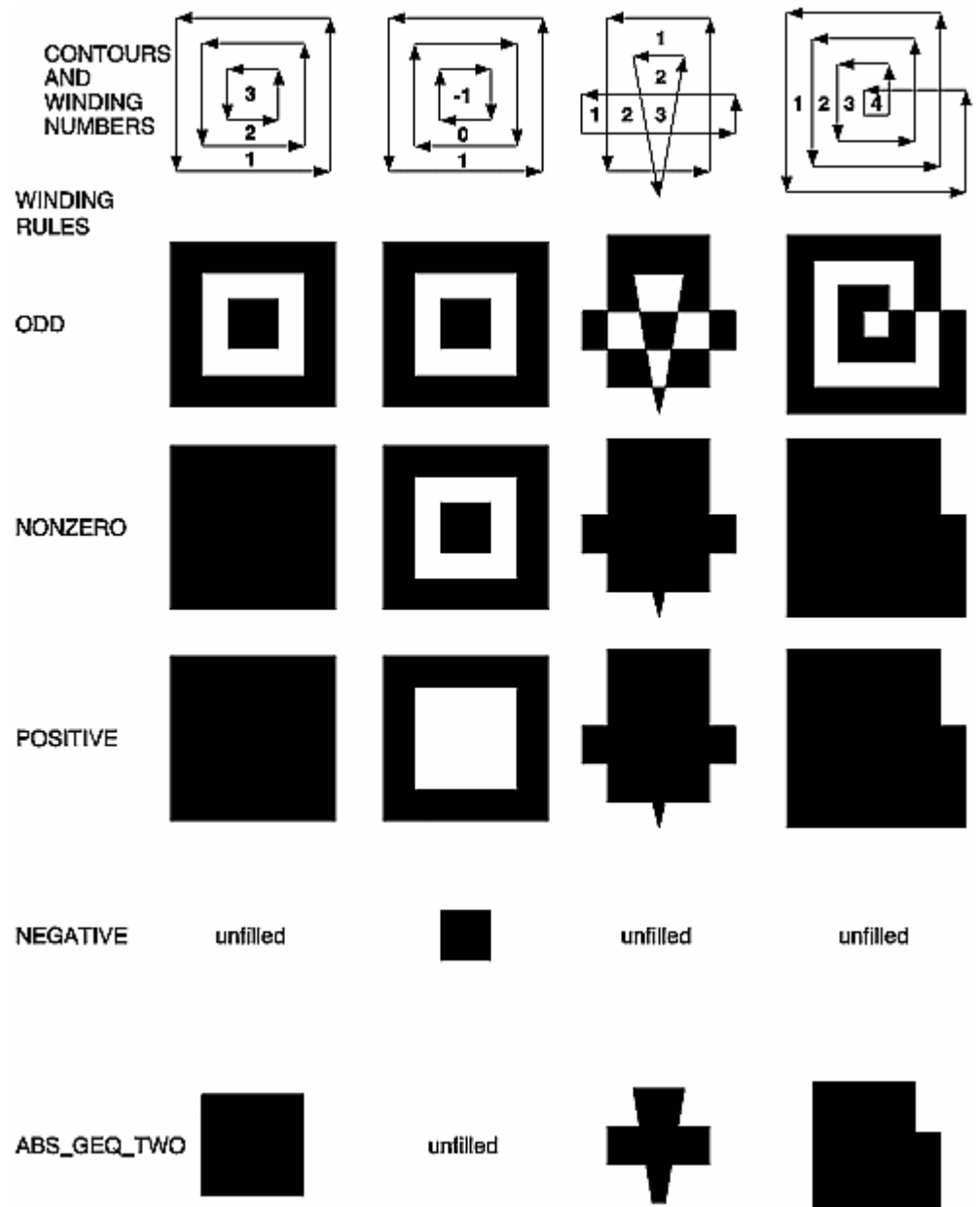
# Convex vs. Concave

- Convex polygons: Given any two points  $\mathbf{a}$  and  $\mathbf{b}$  in the polygon  $\mathbf{c} = f\mathbf{a} + (1-f)\mathbf{b}$  is also inside the polygon for any  $f$  in  $(0,1)$
- Concave polygons: Some  $\mathbf{c}$  is outside the polygon
- Concave examples:

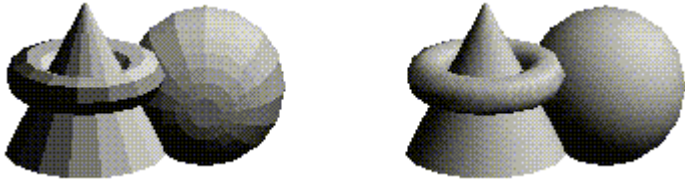


- OpenGL requires **convex** polygons

# What is Inside?

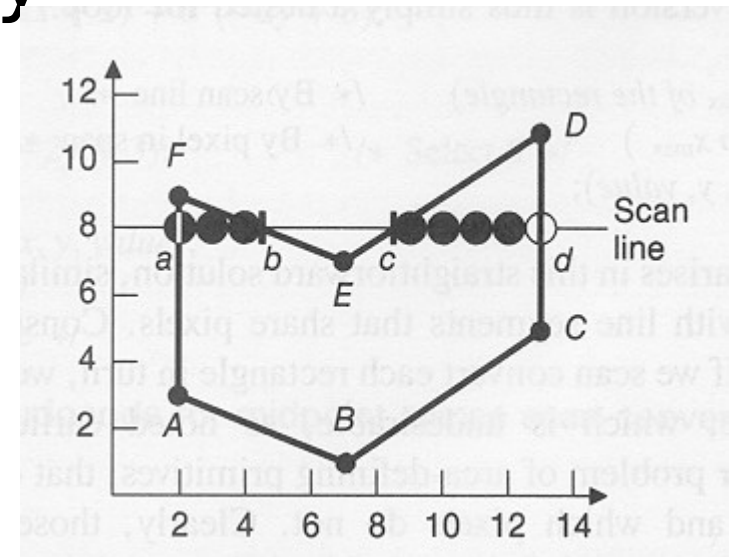


# Normals for Polygons

- Given 3 points in the plane  $P_1$ ,  $P_2$  and  $P_3$ 
  - Normalize  $(P_2 - P_1) \times (P_3 - P_1)$
  - Use any three distinct vertexes of the polygon not on a line
- True Gouraud shading 
  - Calculate normals for all polygons
  - At common vertexes, average all the normals
  - Interpolate across polygons
- OpenGL normals are set at vertexes

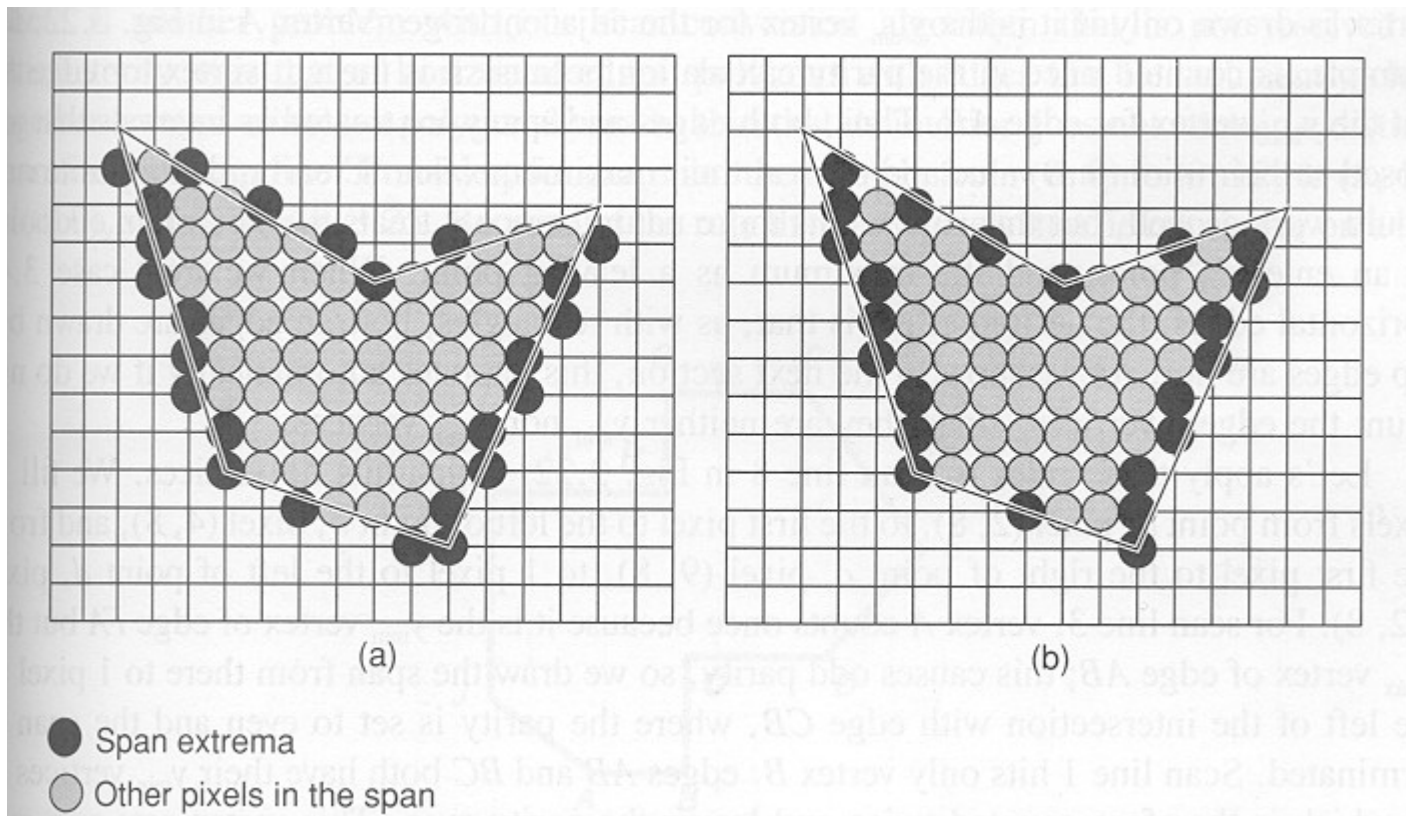
# Scan Converting Polygons

- Draw horizontal lines to fill the polygon
- Pairs of points are interior
- Vertices on a scanline is a problem
- Convex polygons are easy



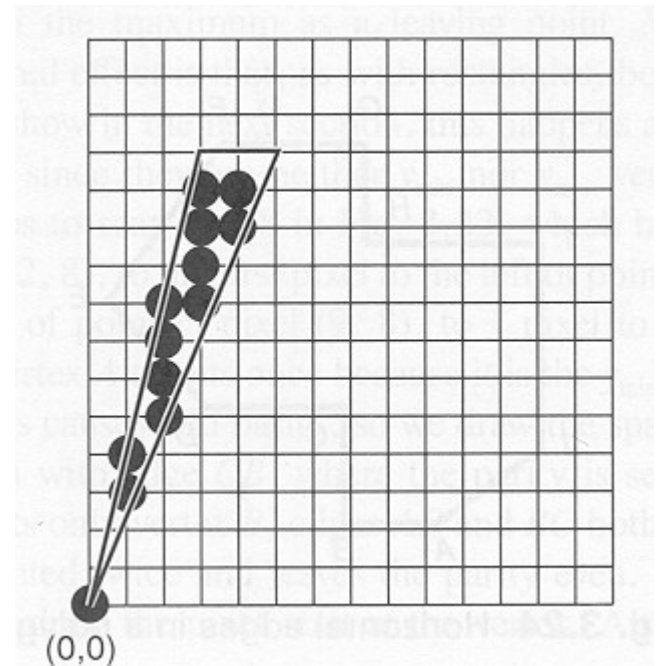
# Deciding the Polygon Extent

- (a) Bresenham Outline
- (b) Strictly Interior Outline



# Edge Coherence

- Scan lines intersects near the last scanline
- Slivers may be just a line





# OpenGL Polygons

- `glPolygonMode(type)`
  - `GL_POINT` draws vertexes
  - `GL_LINE` draws outline
  - `GL_FILL` fills polygon
- `glPolygonStipple(mask)`
  - 32x32 pixel (byte) mask
  - `glEnable(GL_POLYGON_STIPPLE)`