

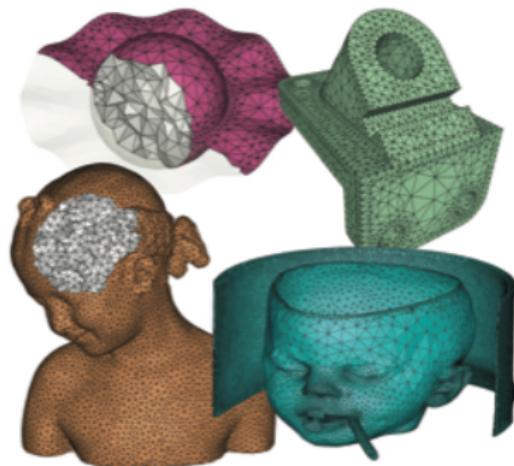
CS 461 - Computer Graphics

Surface Representations



Types of meshes

- ▶ Surface meshes
- ▶ Volume meshes

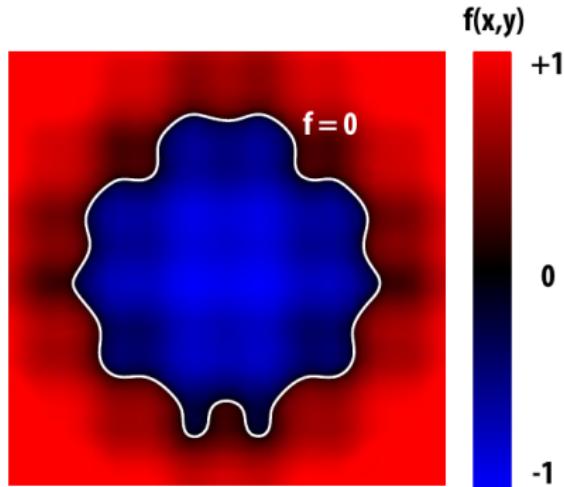


Representations

- ▶ Implicit
- ▶ Explicit
- ▶ Parametric

Implicit Surfaces

- ▶ Points are not given directly - but satisfy some relationship
- ▶ eg: $x^2 + y^2 + z^2 = 1$
- ▶ $F(x,y,z)=0$



Implicit surfaces - examples

- ▶ Algebraic surfaces
- ▶ Constructive Solid Geometry
- ▶ Blobby surfaces (Metaballs)
- ▶ Level-set methods

Algebraic surfaces

- ▶ Surface is a zero set of a polynomial



$$x^2 + y^2 + z^2 = 1$$

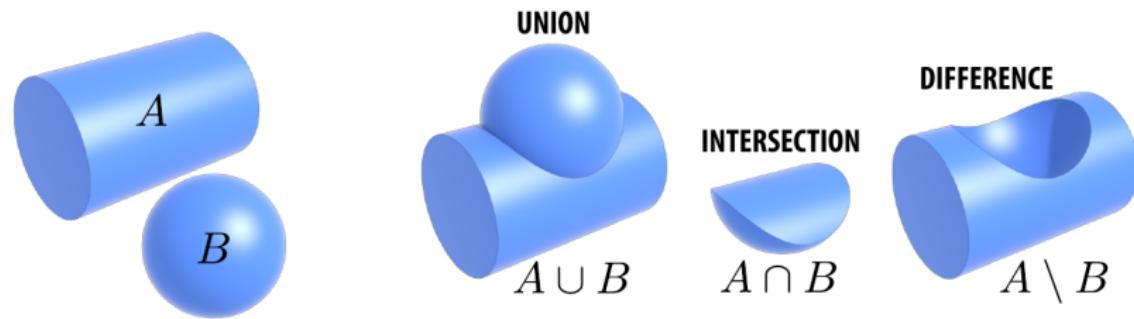


$$(R - \sqrt{x^2 + y^2})^2 + z^2 = r^2$$

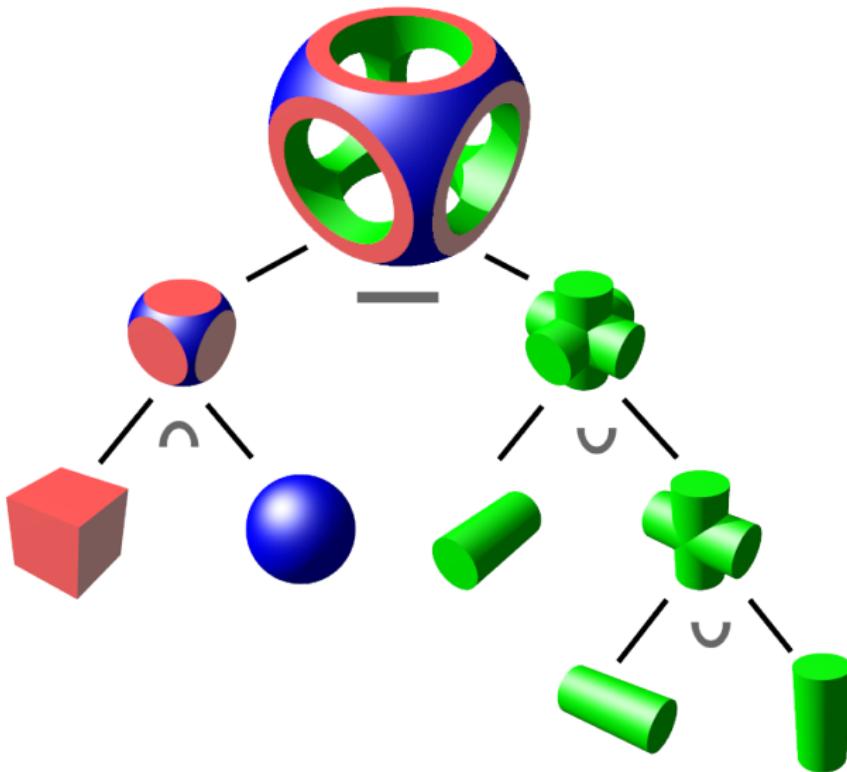


$$\begin{aligned} & (x^2 + \frac{9y^2}{4} + z^2 - 1)^3 = \\ & x^2 z^3 + \frac{9y^2 z^3}{80} \end{aligned}$$

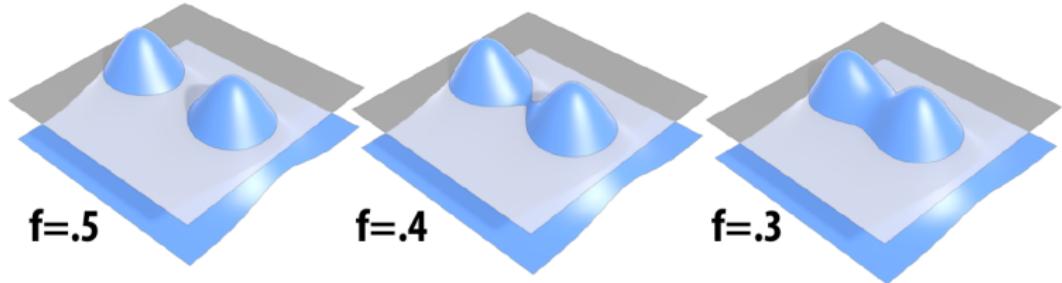
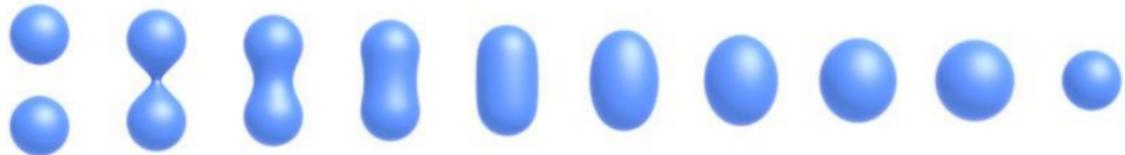
Constructive Solid Geometry



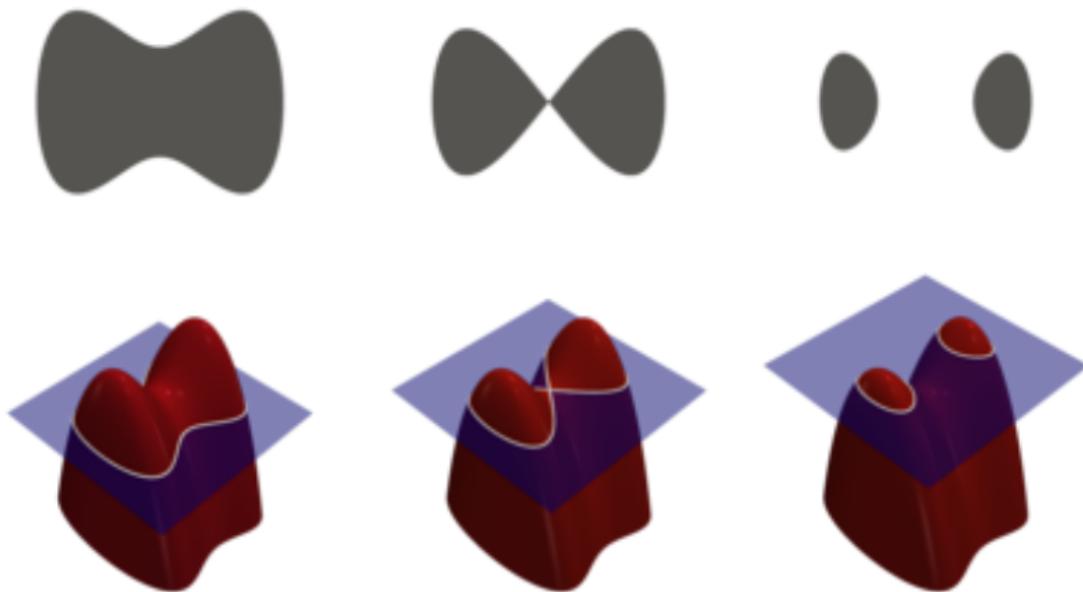
Constructive Solid Geometry



Blobby surfaces



Level set method



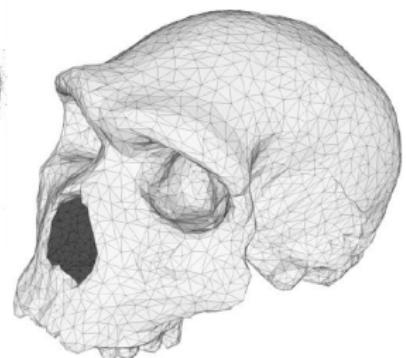
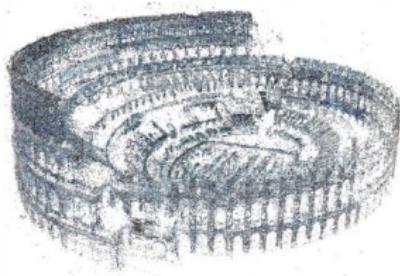
Implicit Surfaces - Pros & Cons

- ▶ Pros:
 - ▶ Very compact description
 - ▶ Easy queries
 - ▶ No sampling error
 - ▶ Fluids...
- ▶ Cons:
 - ▶ Expensive for drawing
 - ▶ Complex shapes



Explicit surfaces

- ▶ Point clouds
- ▶ Polygonal Mesh



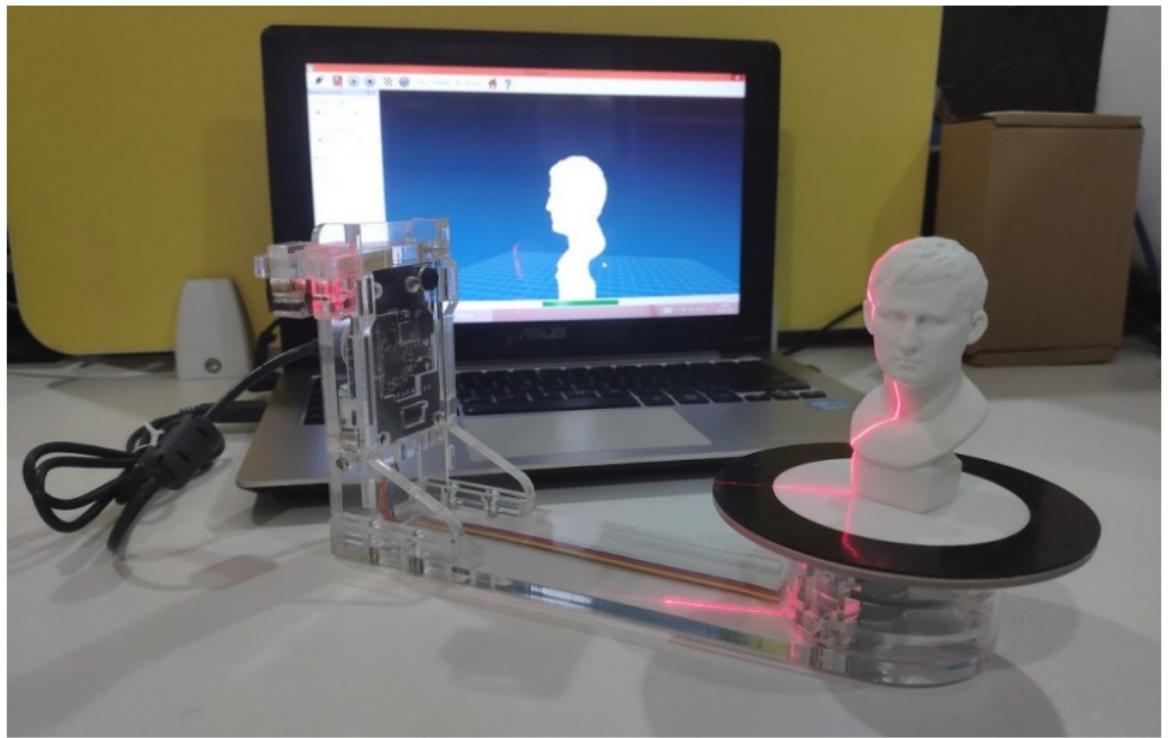
Point clouds



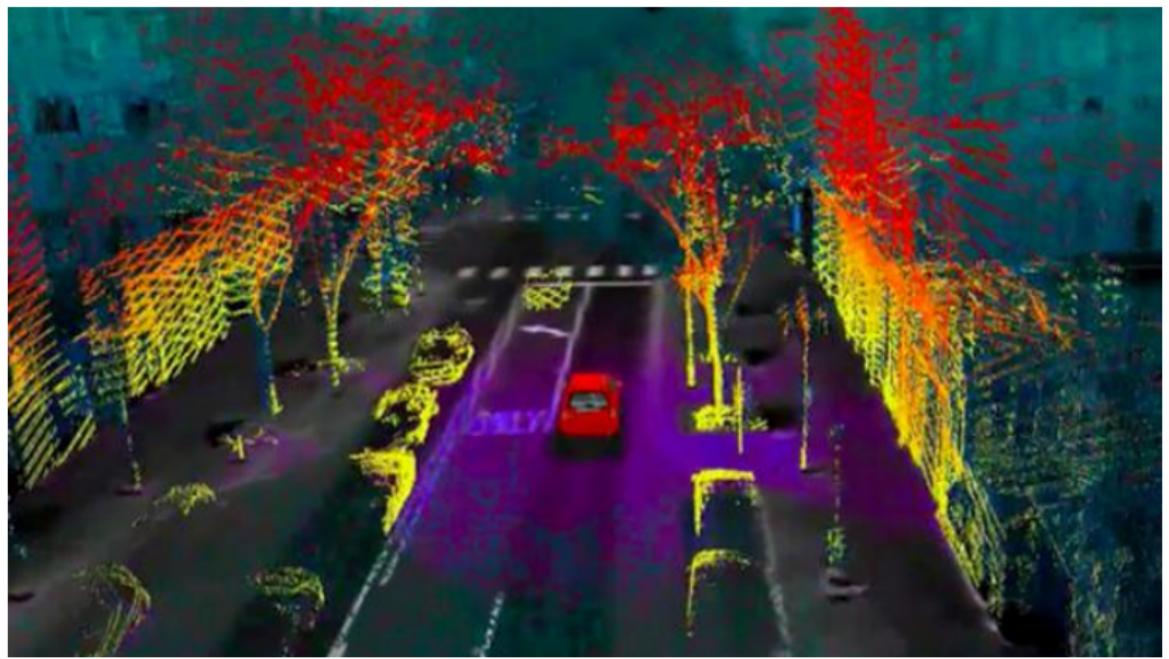
Point clouds



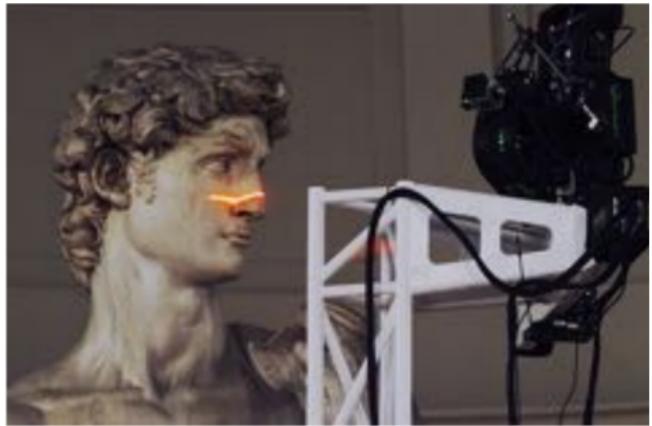
Point clouds



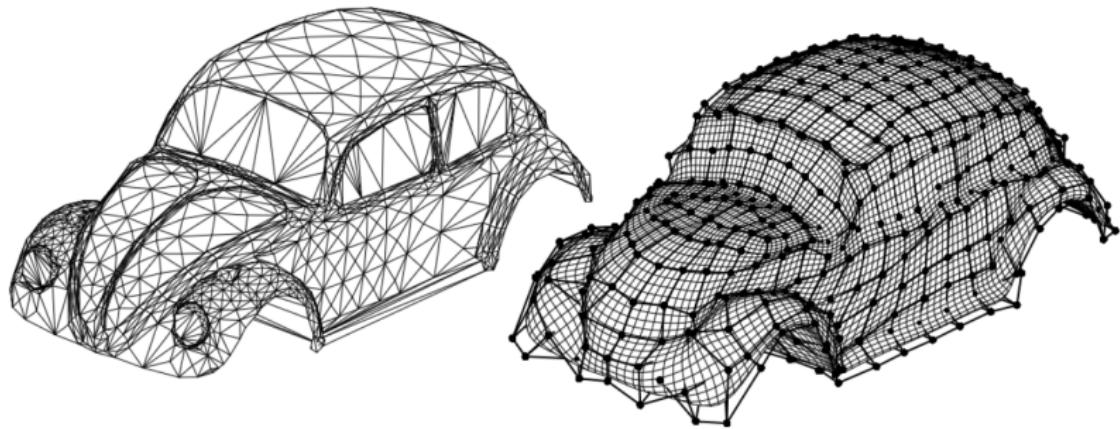
Point clouds



Digital Michelangelo Project

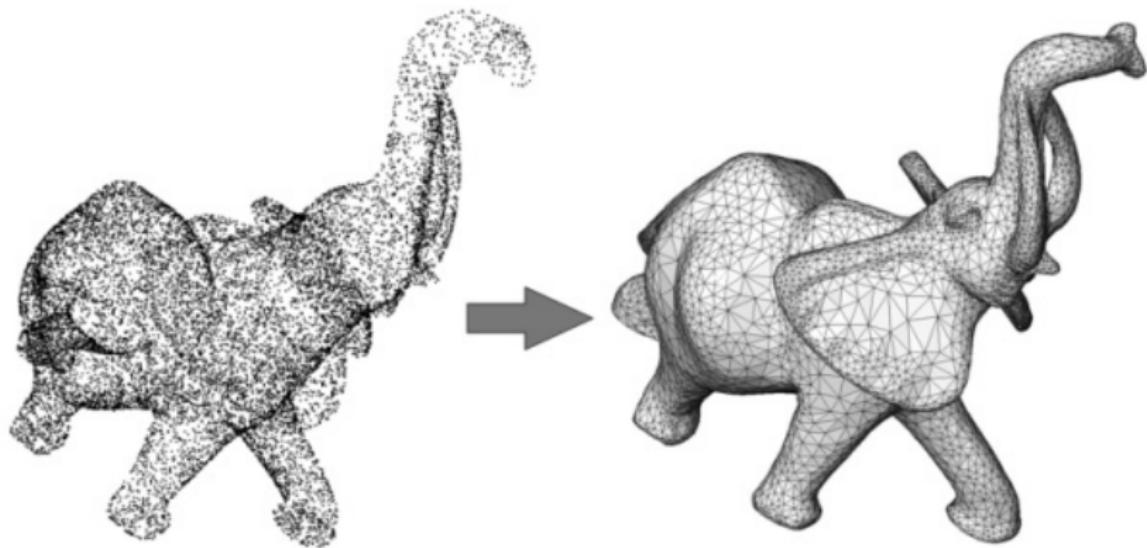


Polygon Mesh



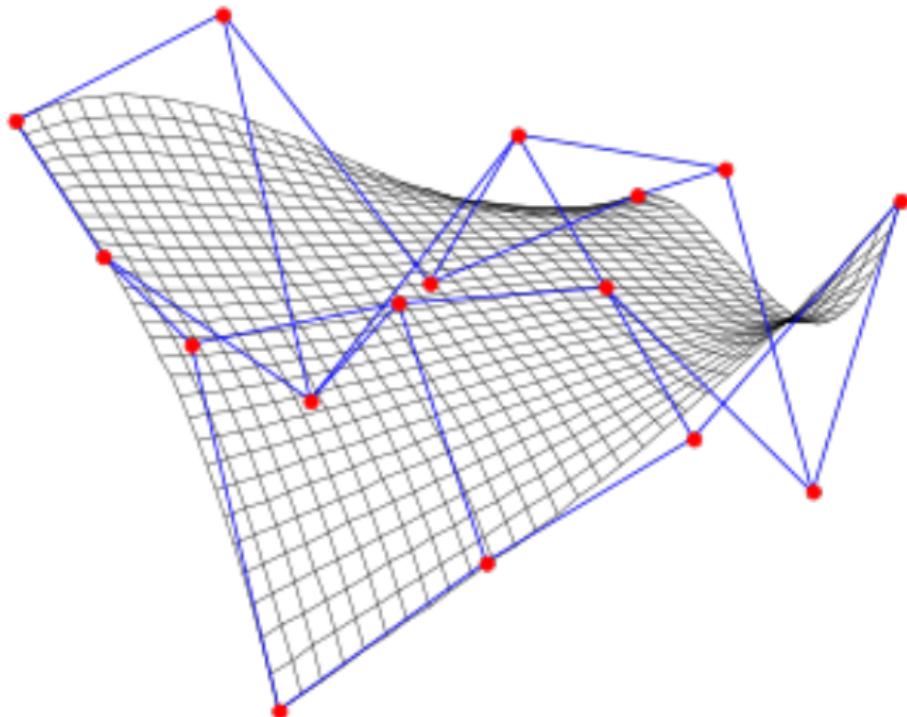
Reconstruction

- ▶ Different methods

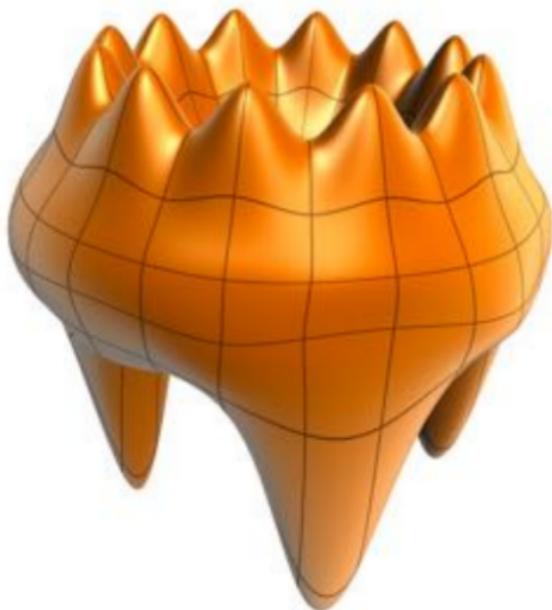
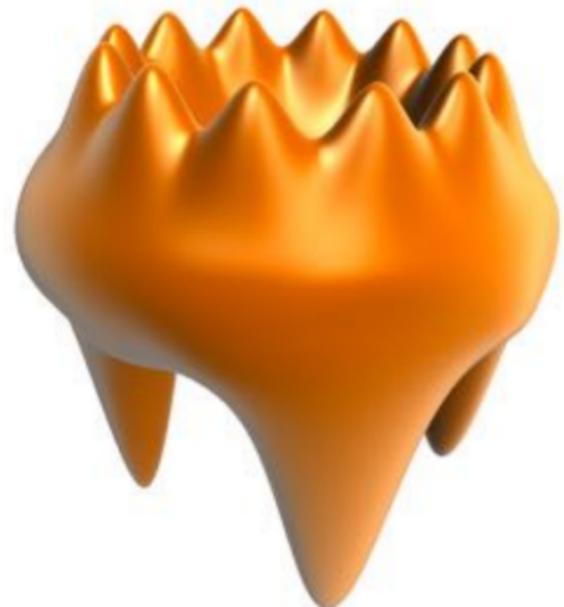


Parametric Surfaces

- ▶ A set of points and their connections Smooth surface



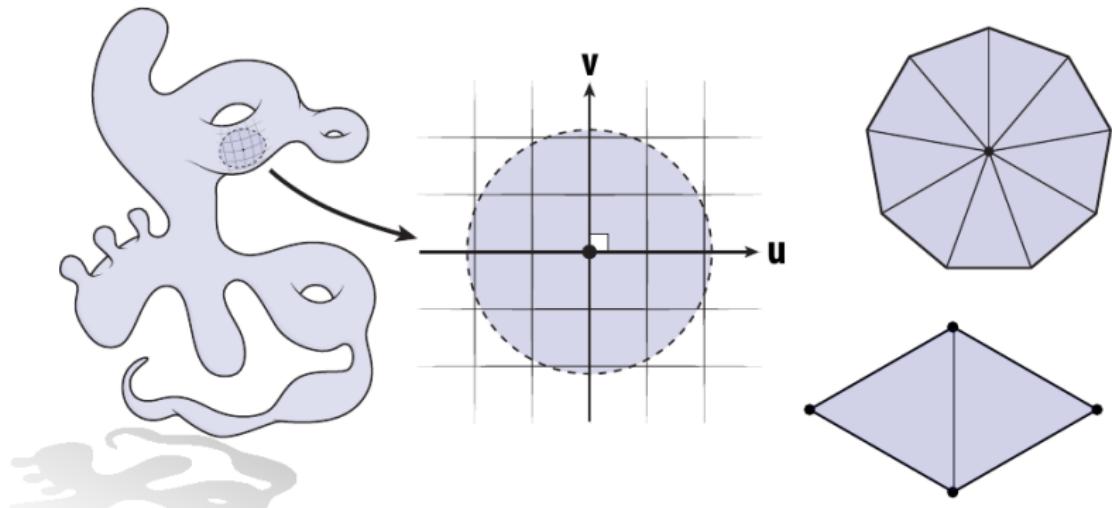
Parametric Surfaces



Utah teapot

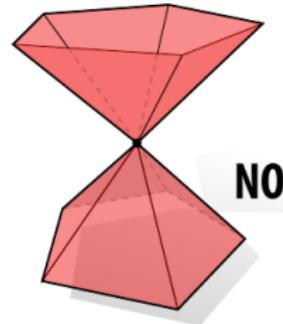
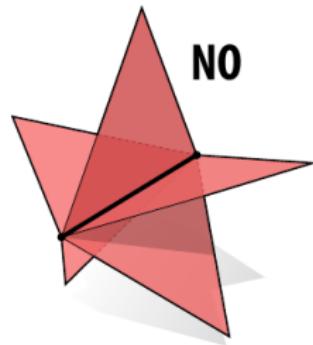
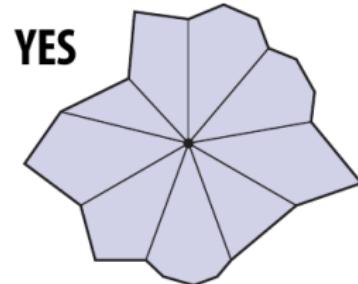
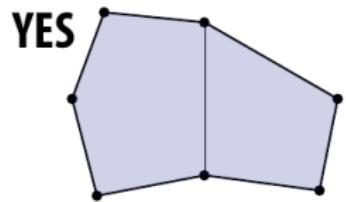


Manifoldness

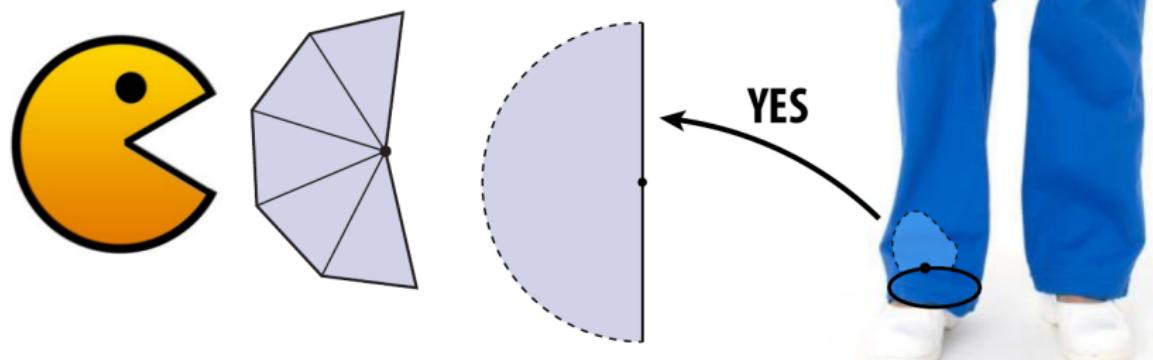


Manifoldness

- ▶ No fin
- ▶ Fan structure

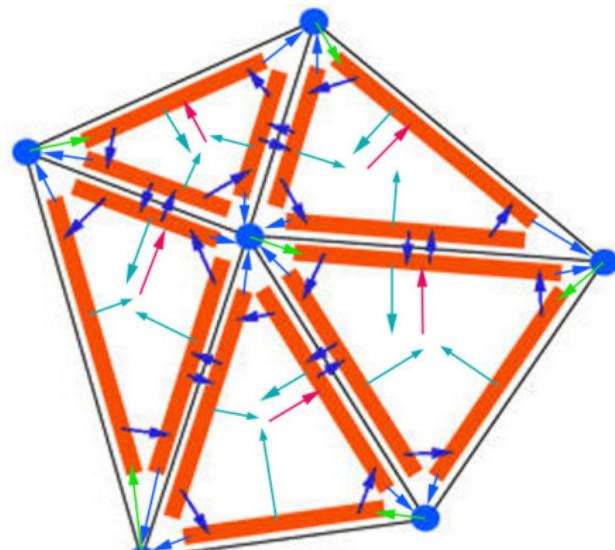


Manifoldness - boundary



Data structure for polygonal models

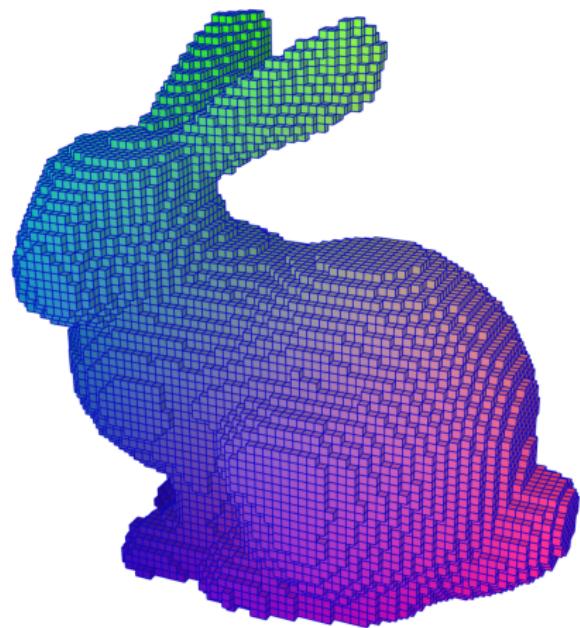
- ▶ Half-edge data structure, ...



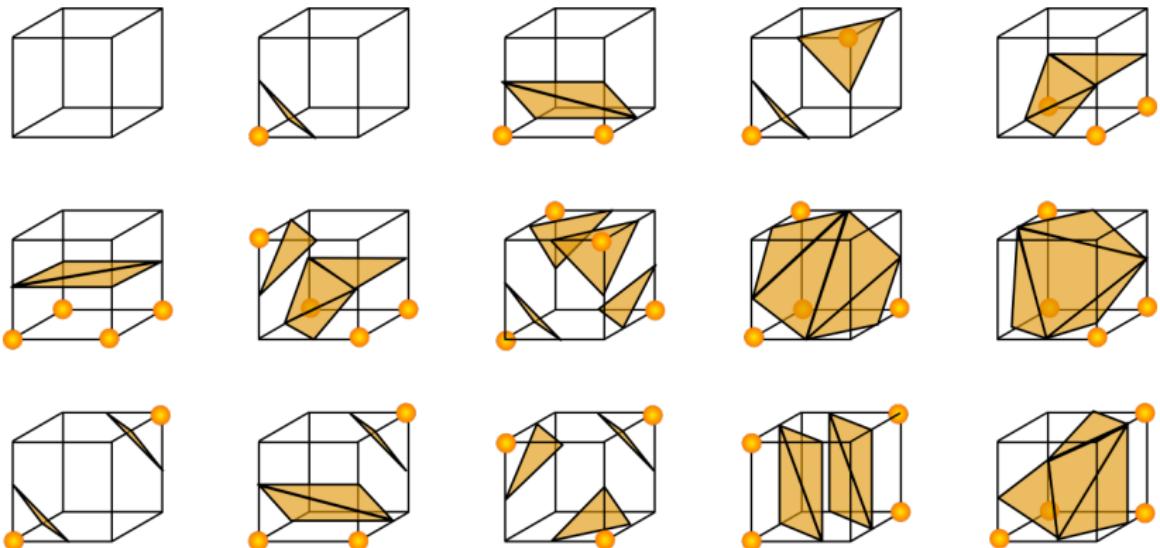
Half-edge data structure

- ▶ Sibling Edge pointers
- ▶ Next Edge pointer
- ▶ Source Vertex
- ▶ Face pointer
- ▶ Every Face points to just one edge
- ▶ Every Vertex points to just one edge

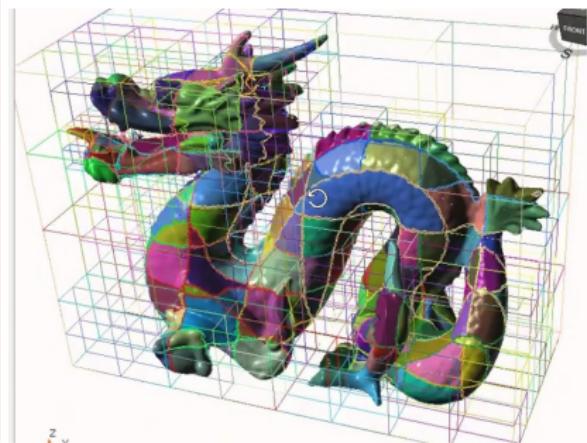
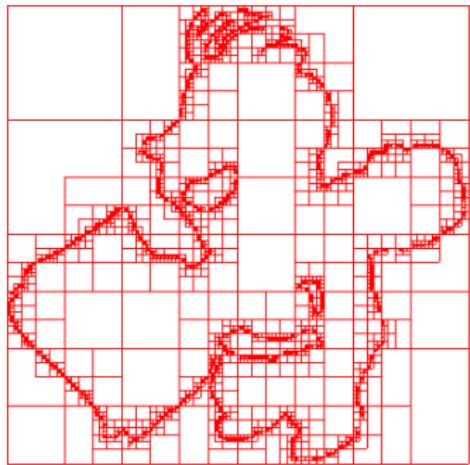
Voxels



Marching Cubes



Binary Space Partition trees



For you :-)

- ▶ Written assignment - Can you define an implicit function given a set of points? - concept of normal - Poisson surface reconstruction
 - ▶ The intuition behind it
 - ▶ Mathematical background
 - ▶ How it is working
- ▶ Deadline - 1st October midnight
- ▶ Lab assignment - Rotate and Zoom 3D model using mouse
- ▶ Deadline - 3th October midnight
- ▶ Project topic and abstract
- ▶ Deadline - 6th October midnight

Next class

- ▶ October 1st - 9 to 10
- ▶ Topic: Digital Geometry Processing