Parametric Surfaces

Friday, January 25, 2008
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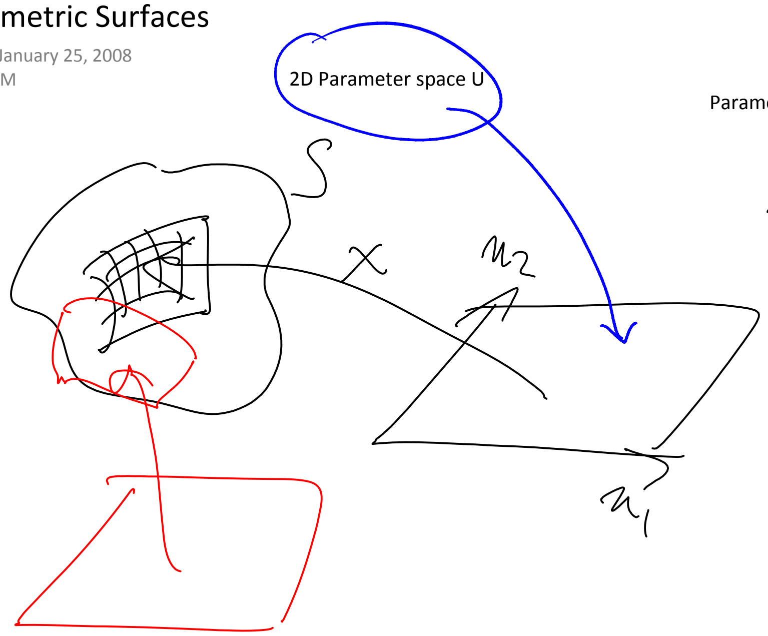


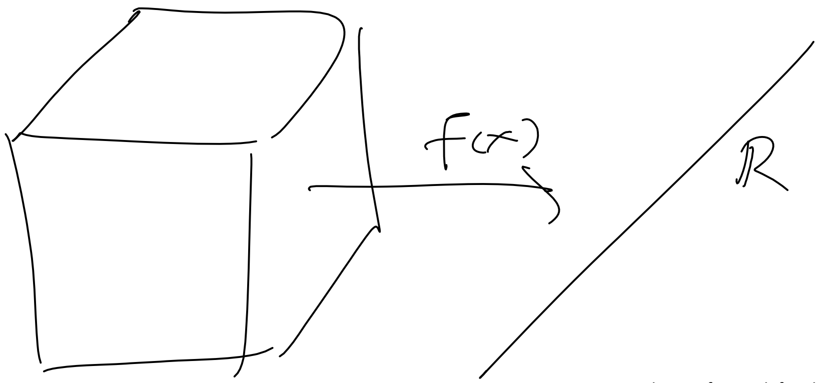
Parameterization: function defined on U with values in 3D

$$X(u_1, u_2) \in \mathbb{R}^3$$

PARAMETRIC

Implicit Surfaces

Friday, January 25, 2008
2:13 PM



An Implicit surface is defined as the set of zeros of a continuous function of 3 variables
The defining function is usually called "implicit function"

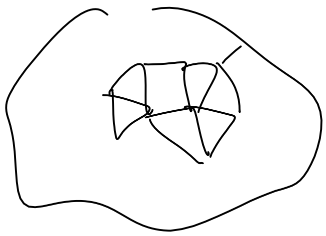
$$S = \{x : f(x) = 0\}$$

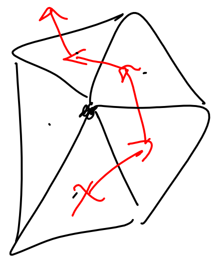
Inside $\{x : f(x) \leq 0\}$

An implicit function also defines an "inside" and an "outside"
These are normally "solid" objects

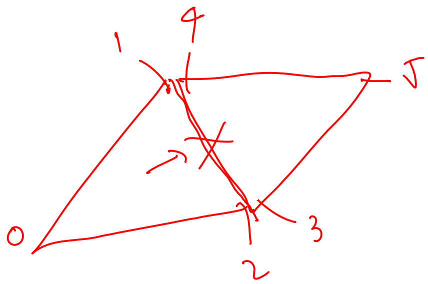
Mesh Traversal

Friday, January 25, 2008
2:15 PM





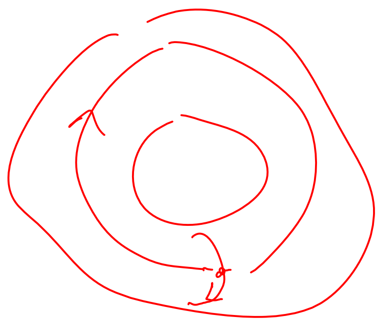
We need data structures representing the incidence relations existing amongst vertices, edges, and faces to enable fast and efficient traversal

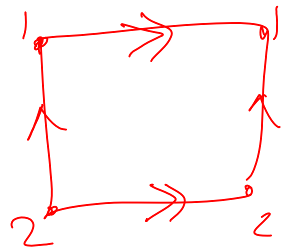


Topology

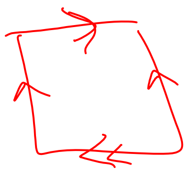
Friday, January 25, 2008
2:25 PM

Connectivity vs. Topology





Topology of a closed manifold surface is the number of "handles"

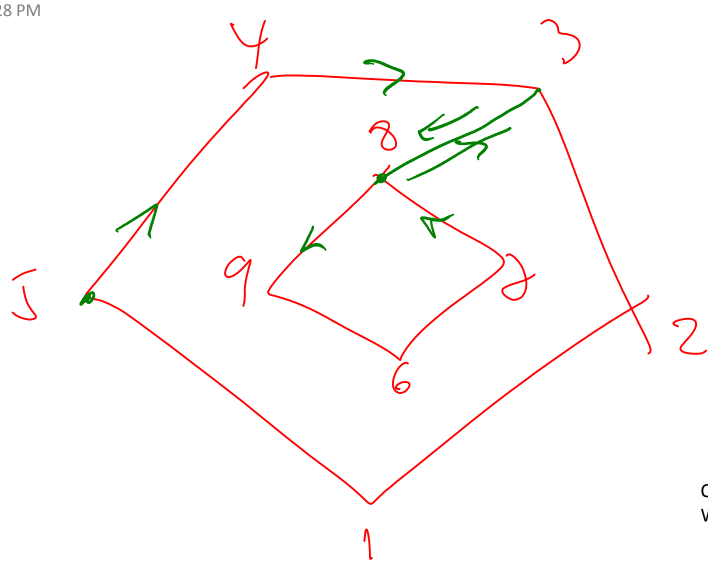


Surfaces with boundary contain a number of "holes"
The boundary of each hole is a closed loop of vertices and edges
If each hole is filled with a new face, a

Repeating vertex indices is possible in our data structure, but not valid.

Faces with holes

Friday, January 25, 2008
2:28 PM



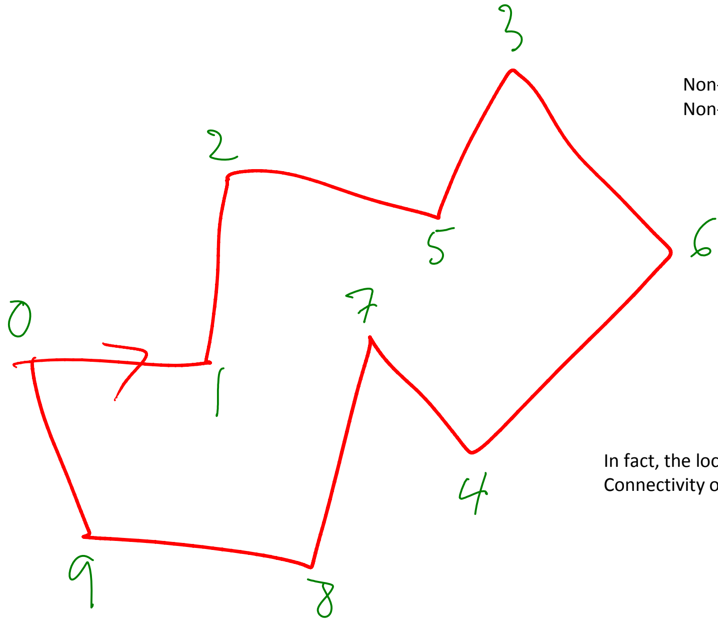
Can be represented by allowing repeated vertex indices within a face
We will support these faces in our algorithms

[5, 4, 3, 8, 9, 6, 7, 8, 3, 2, 1, -1]

Non-convex faces

Friday, January 25, 2008
2:32 PM

Non-convex faces are OK
Non-planar faces are OK too



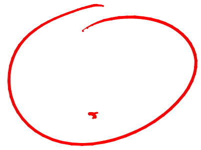
In fact, the location of the vertices in space is irrelevant for all the Connectivity oriented surgery operations

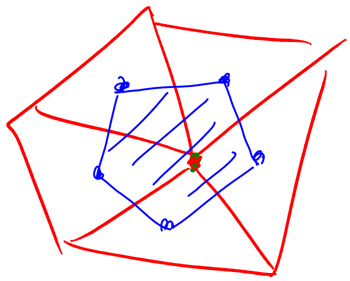
[0, 1, 2, 5, 3, 6, 4, 7, 8, 9, -1]

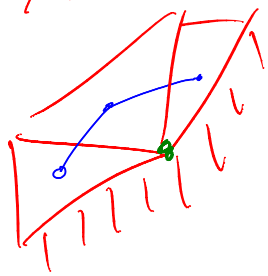
A valid face is any loop of vertices without repetition.

Regular, Singular, Boundary Vertices

Friday, January 25, 2008
2:33 PM

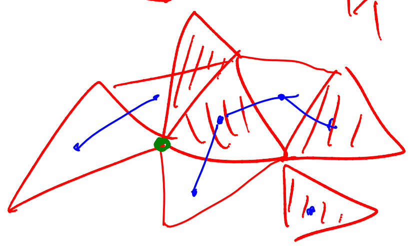






We need to look at the dual graph of the submesh composed of all the faces incident to the vertex of interest

The vertex is regular if and only if this graph is connected



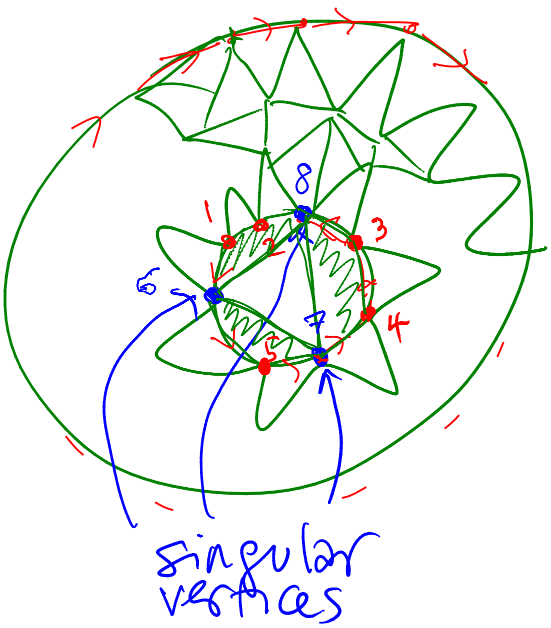
How to classify all the vertices?

1) Convert to manifold connectivity (next class)
2) For each vertex of the source mesh, count the number of corresponding vertices in the manifold mesh
3) Regular vertices are those in 1-1 correspondence

The vertex is "boundary" if it belongs to a boundary edge;
Otherwise it is "internal"

Non-Manifold Meshes

Friday, January 25, 2008
2:41 PM



Some non-manifold meshes can be converted to manifold by adding faces supported on existing vertices