3D objects representation and data structure

Dr Nicolas Holzschuch
University of Cape Town
e-mail: holzschu@cs.uct.ac.za

Map of the lecture

- Object representations in 3D
  - internal/external
- Data structure
  - vertex list, edge list, winged edge
- Plane equation
  - computing the plane equation

Objects representation

- In application model
- Will be modified by the application
- Ultimately, will be send for display
- Must be adapted for both tasks

Sending to display

- Need the list of faces, with list of vertices for each face
- Redundant information not a problem
  - one vertex may appear several times
- Neighbouring information not needed
- Data structure:
  - list of faces
  - list of vertices for each face

Access by the application

- Modification of the application model
  - moving vertices
  - adding new faces
  - adding new vertices
  - redundant information is excluded
- Needs neighbouring information
  - for coloring
  - for computing average normals (shading)

Internal *vs.* external

- External data structure:
  - used for display
  - can be very simple
- Internal data structure
  - will have complex manipulations
  - must provide for these manipulations

Vertex list

- List of faces
- For each face:
  - list of pointers to vertices
- Good points:
  - redundancy removed. Space saved.
- Bad points:
  - find which polygons share an edge, or a given vertex?

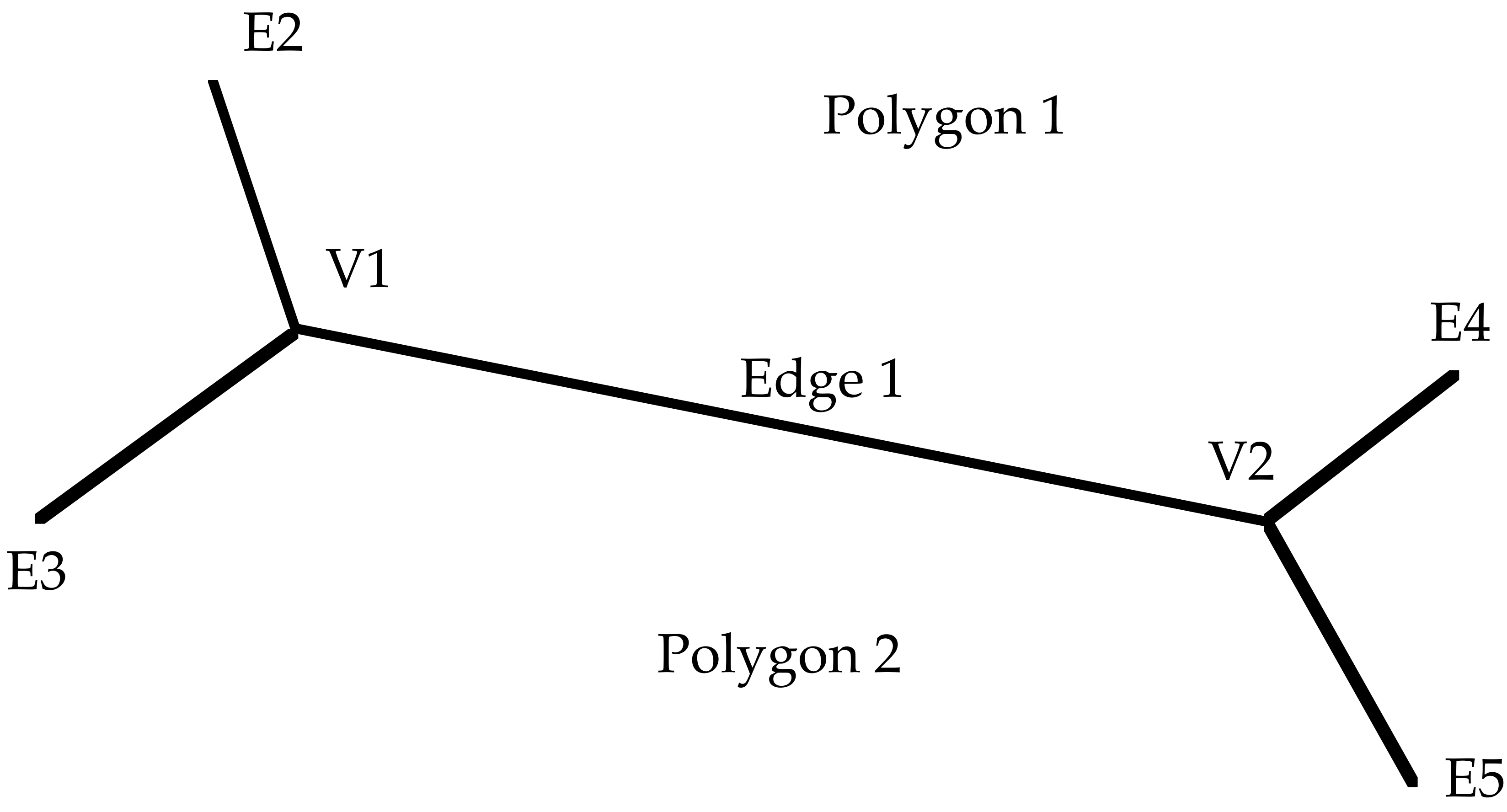
Edge list

- For each face:
  – list of pointers to edges
- For each edge:
  – the two polygons sharing it
  – the two vertices
- Neighbouring information available
  – faces adjacent to an edge

Edge list: shortcomings

- List of polygons sharing a vertex?
- I move a vertex:
  - I need to find which edges share this vertex
  - must go through the whole list
- I add a face, an edge:
  - must go through the whole list

Winged-edge data structure



Winged-edge data structure

- Each vertex also has a pointer to one of its edges
- Each face has a pointer to one of its edges
- Efficient:
  - faces adjacent to one vertex
  - edges adjacent to one vertex

Plane equation

- Each face is a planar polygon
- Plane equation: $ax+by+cz+d = 0$
- Normal to the plane: (a,b,c)
- Finding the equation?

Finding a plane equation

- Plane defined by three points: P1,P2,P3
- First, find the normal:

  n = P1P2 ^ P1P3
- If **n**=0? then it isn't a plane
- **n** gives *a*,*b* and *c*
- Find *d* using P1

Using a plane equation

- **n** is fundamental:
  - defines a front and a back
  - M is in front of the plane: P1M•**n** ≥ 0
  - M is behind the plane: P1M•**n** ≤ 0
- Same classification using the equation:

$$ax+by+cz+d \geq 0$$

3D objects: conclusion

- Data structure essential
  - must be adapted to the task
  - trivial data structure sufficient for display
  - more complex data structure required for application
- Plane equation