Computergrafik

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Today

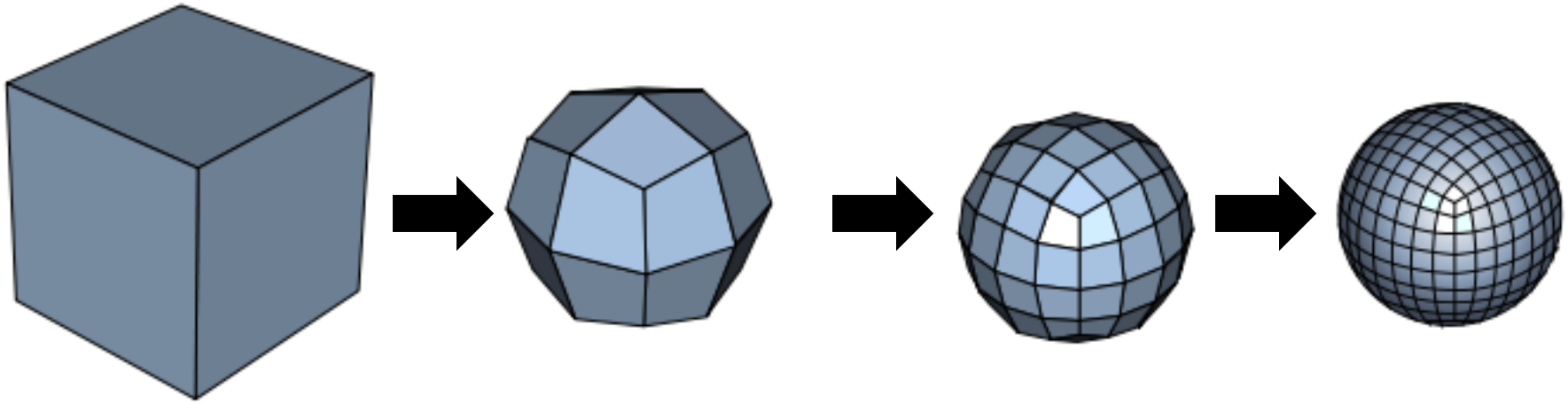
- Mesh data structures

Acknowledgement: With figures from

http://www.cs.princeton.edu/courses/archive/spring10/cos426/lectures/06-mesh.pdf

Subdivision surfaces

http://en.wikipedia.org/wiki/Catmull%E2%80%93Clark_subdivision_surface



Input mesh

Subdivision & smoothing

Subdivision & smoothing

Subdivision & smoothing

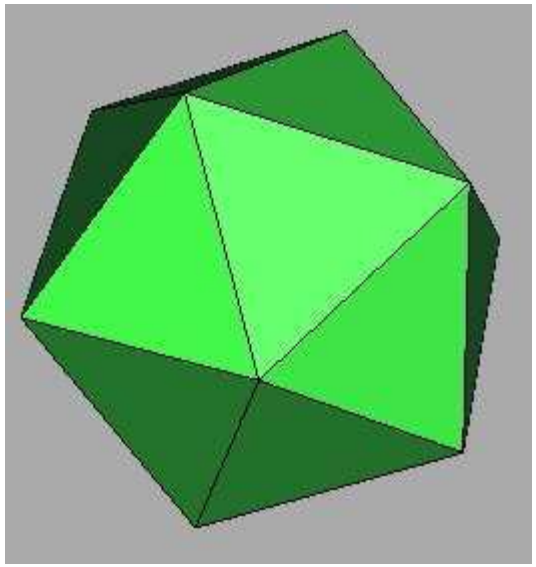
Limit surface

Subdivision surfaces

- Smoothing step
  - Local average of neighboring vertices
  - Various schemes
- Need access to adjacency information of mesh
  - Given edge, what are adjacent faces?
  - Given vertex, what are adjacent edges?
  - Etc.

Mesh data structures

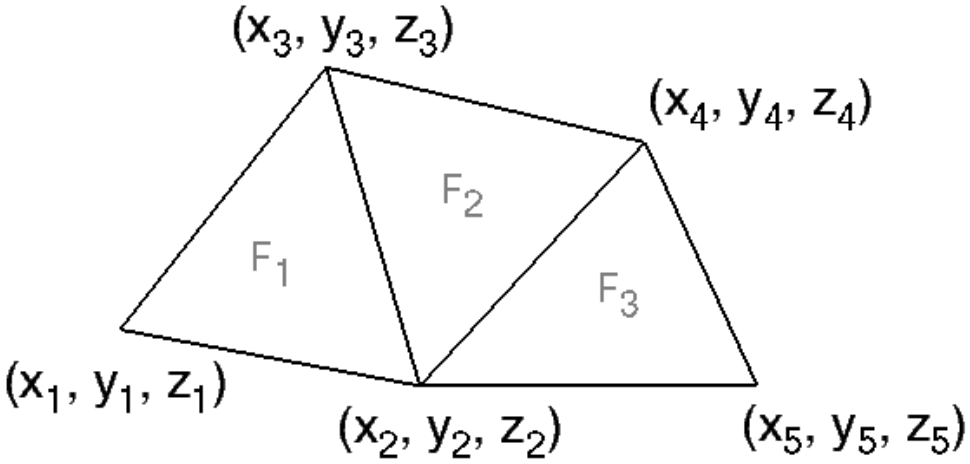
1. Independent faces
2. Vertex and face tables
3. Adjacency lists
4. Winged-edge data structure



Independent faces

- Redundant vertices
  - Each vertex position stored for each face
- No adjacency information
- „Polygon soup“ http://en.wikipedia.org/wiki/Polygon_soup

FACE TABLE	
F_1	(x_1, y_1, z_1) (x_2, y_2, z_2) (x_3, y_3, z_3)
F_2	(x_2, y_2, z_2) (x_4, y_4, z_4) (x_3, y_3, z_3)
F_3	(x_2, y_2, z_2) (x_5, y_5, z_5) (x_4, y_4, z_4)

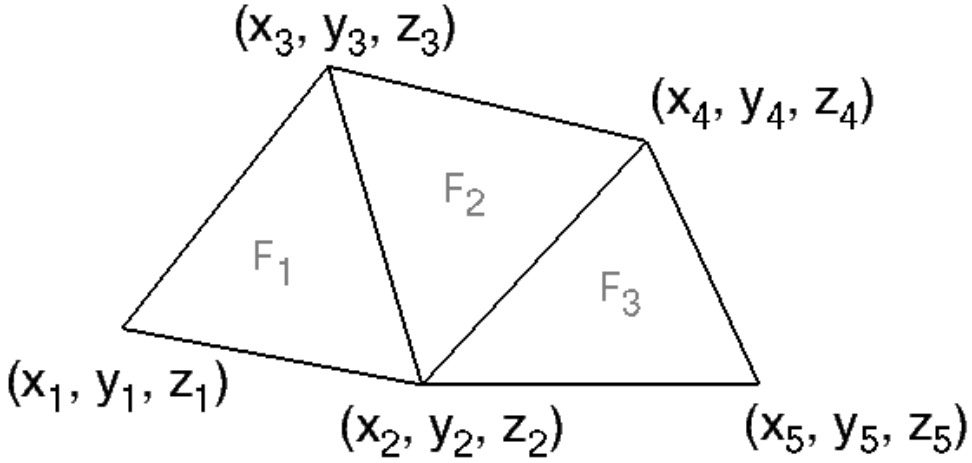


Vertex and face tables

- Each face lists vertex references
- Shared vertices, each vertex position stored only once
- No adjacency information
- Current data structure in jrtr Java code

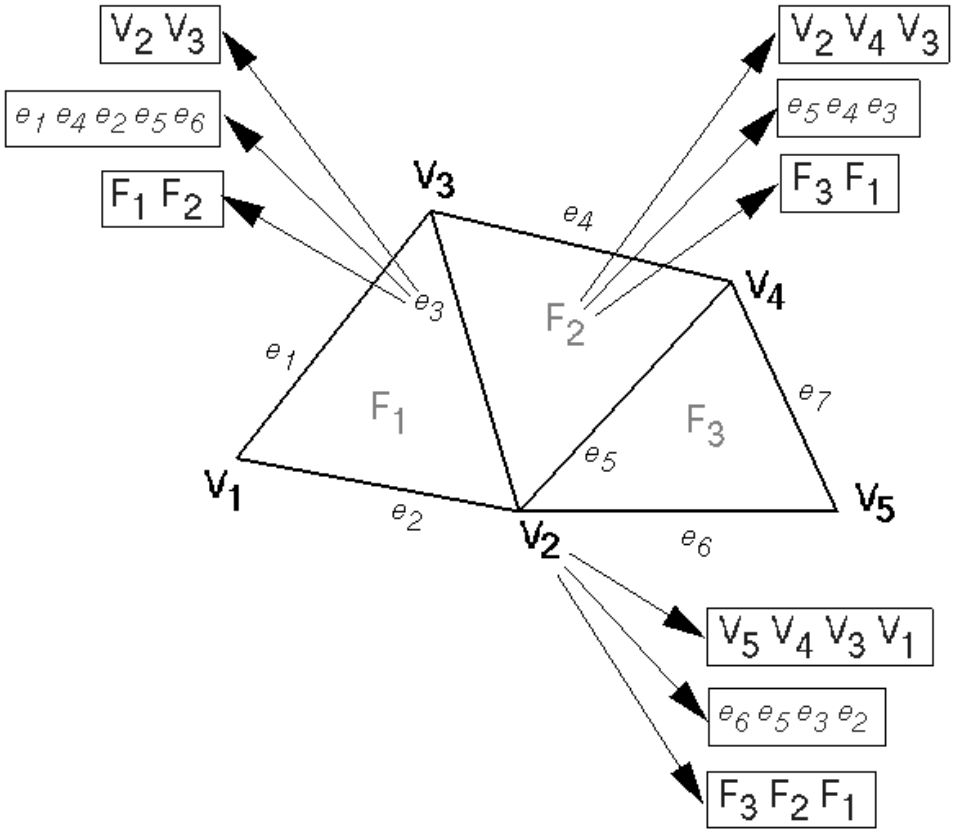
VERTEX TABLE			
v_1	x_1	y_1	z_1
v_2	x_2	y_2	z_2
v_3	x_3	y_3	z_3
v_4	x_4	y_4	z_4
v_5	x_5	y_5	z_5

FACE TABLE			
F_1	v_1	v_2	v_3
F_2	v_2	v_4	v_3
F_3	v_2	v_5	v_4



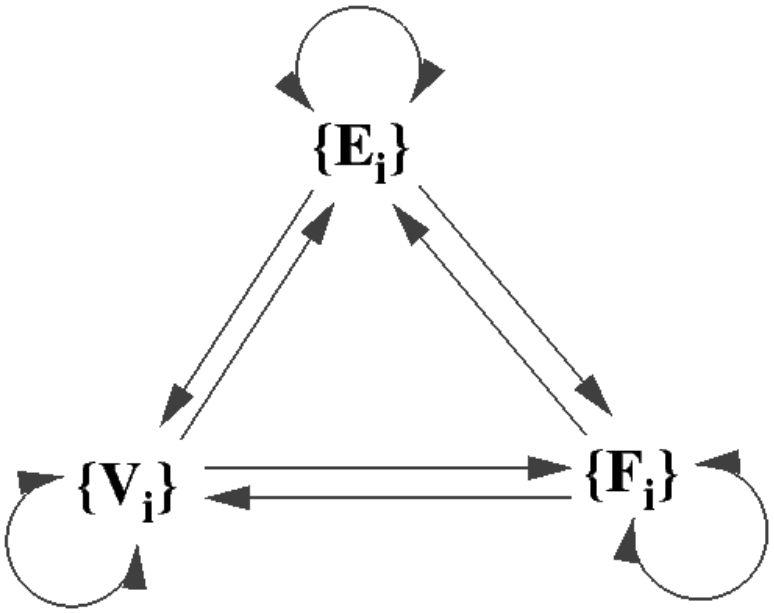
Adjacency lists

- Store all vertex, edge, face adjacencies
- Trivial retrieval of adjacency information
- Extra storage

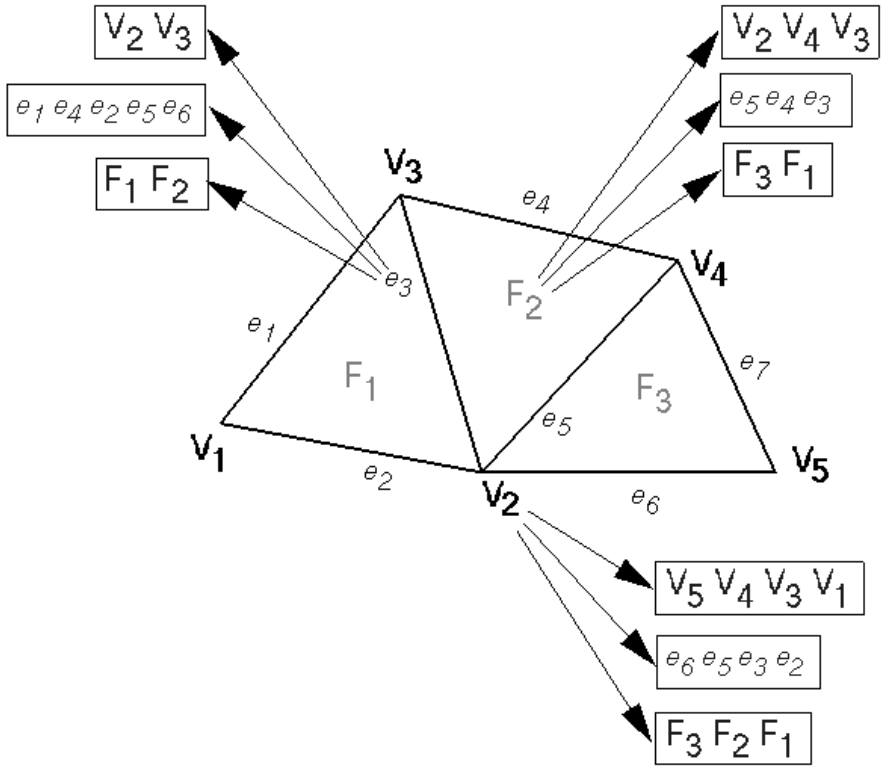


Partial adjacency lists

- Store only some adjacency relations and derive others?

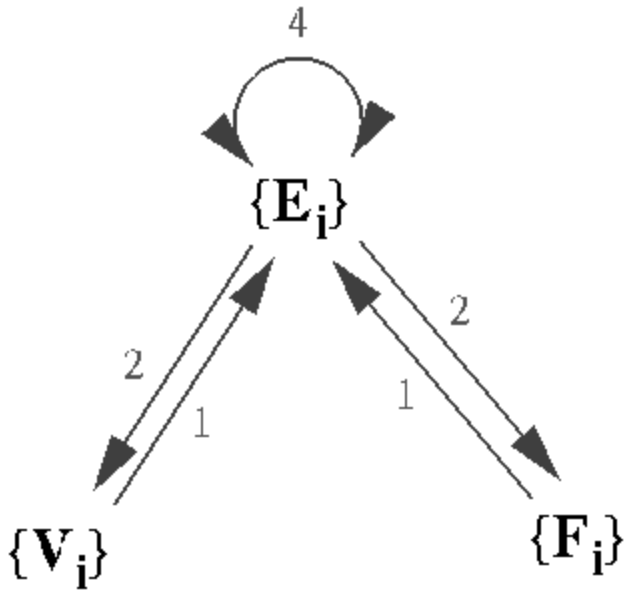


All adjacency relations

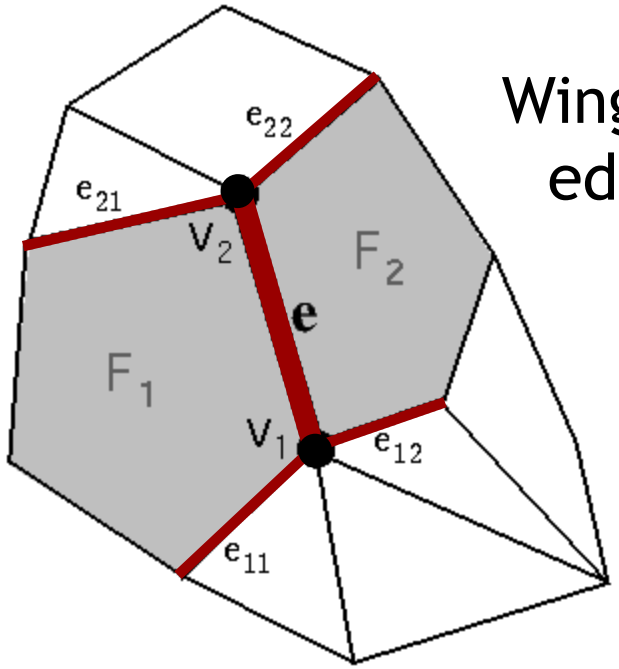


Winged edge data structure

- Adjacency encoded in edges
- Retrieve all adjacencies in constant time
- Little extra storage
- Arbitrary polygons (not only triangles)

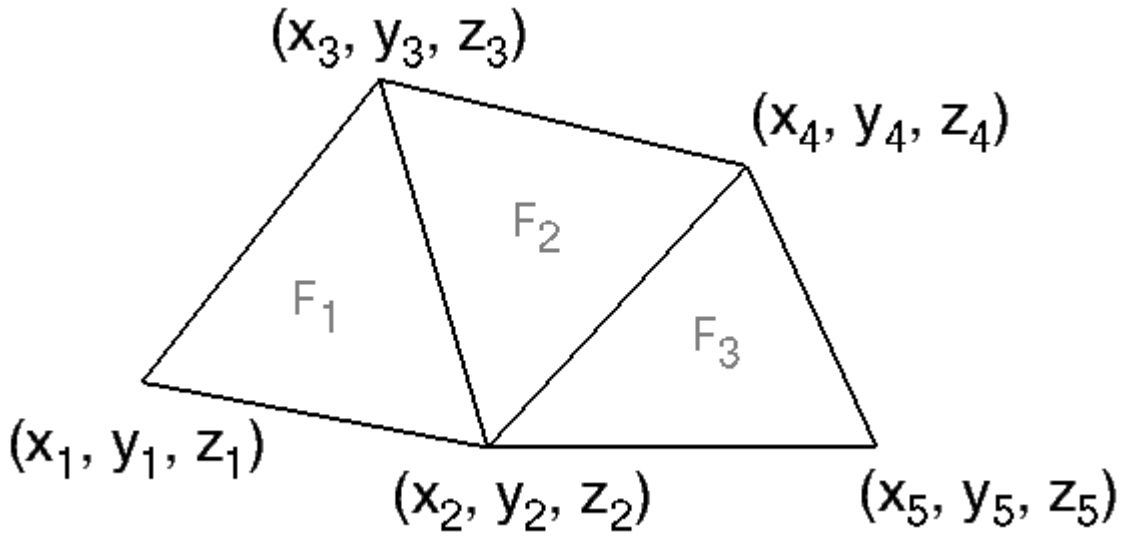


Adjacency relations
in winged edge structure



Winged
edge

Example



VERTEX TABLE				
V_1	X_1	Y_1	Z_1	e_1
V_2	X_2	Y_2	Z_2	e_6
V_3	X_3	Y_3	Z_3	e_3
V_4	X_4	Y_4	Z_4	e_5
V_5	X_5	Y_5	Z_5	e_6

EDGE TABLE					11	12	21	22
e_1	V_1	V_3		F_1	e_2	e_2	e_4	e_3
e_2	V_1	V_2	F_1		e_1	e_1	e_3	e_6
e_3	V_2	V_3	F_1	F_2	e_2	e_5	e_1	e_4
e_4	V_3	V_4		F_2	e_1	e_3	e_7	e_5
e_5	V_2	V_4	F_2	F_3	e_3	e_6	e_4	e_7
e_6	V_2	V_5	F_3		e_5	e_2	e_7	e_7
e_7	V_4	V_5		F_3	e_4	e_5	e_6	e_6

FACE TABLE	
F_1	e_1
F_2	e_3
F_3	e_5

Summary

- Need adjacency information for many mesh processing algorithms
  - E.g., subdivision
- Want efficient data structure
  - Adjacency queries in constant time
  - Little storage overhead
- Winged-edge
  - Other options exist, e.g., half-edge
    http://www.flipcode.com/archives/The_Half-Edge_Data_Structure.shtml

Next time

- More shaders