COS 426: Precept 4

Introduction to Half-Edges

Andy Zeng

Agenda

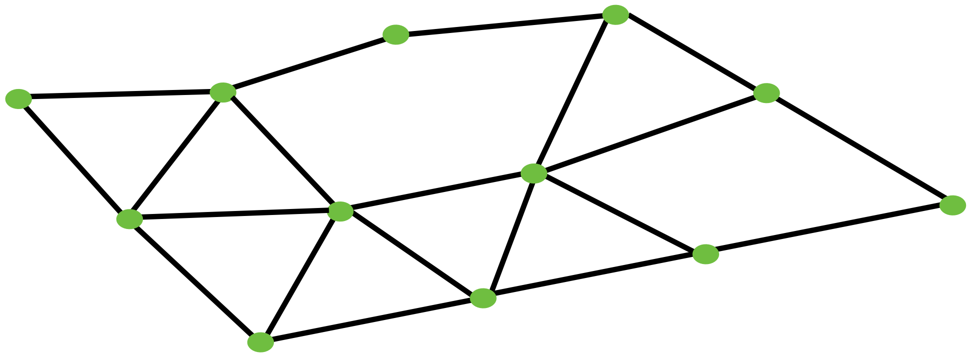
- Assignment 2 description
- Half-edge data structure
    - Traversal
    - Modification

Assignment 2

- Part 1 - Analysis
  - Implement traversal operations
  - Calculate mesh properties
    - Vertex normal, avg. edge length, etc.
- Part 2 - Filters
  - Filters and Warps similar to assignment 1
  - Topological modifiers

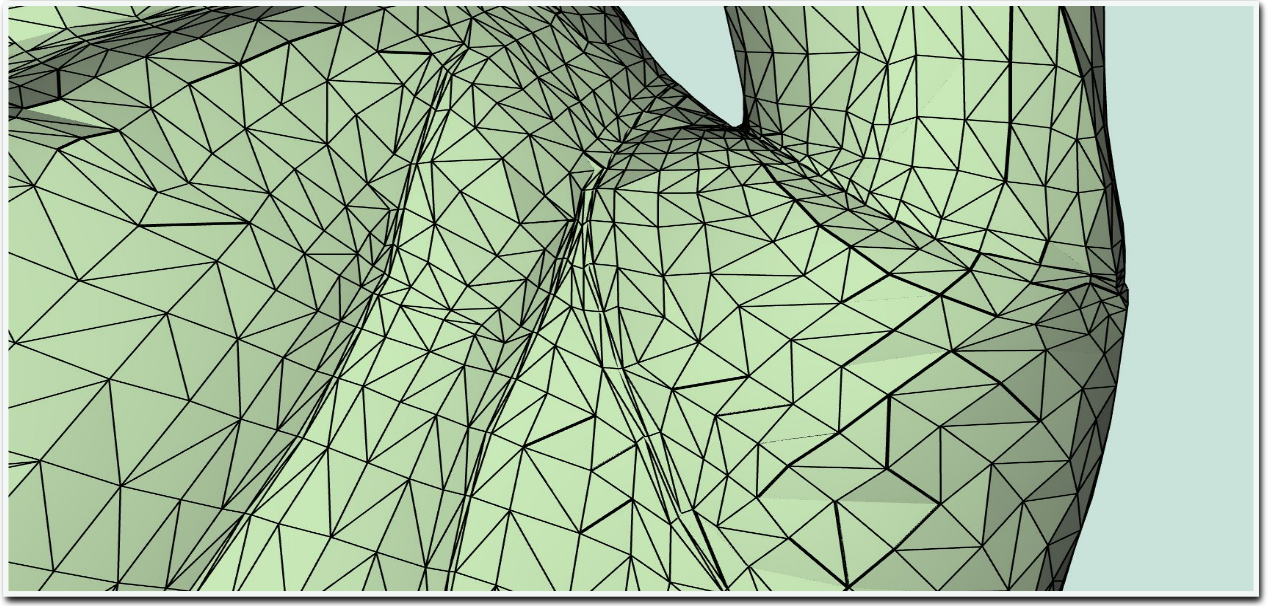
Meshes

- Images had implicit adjacency information
  - Grid around a pixel (access in O(1) time)
  - Easy to express operations
- What about meshes?
  - How to apply smoothing?



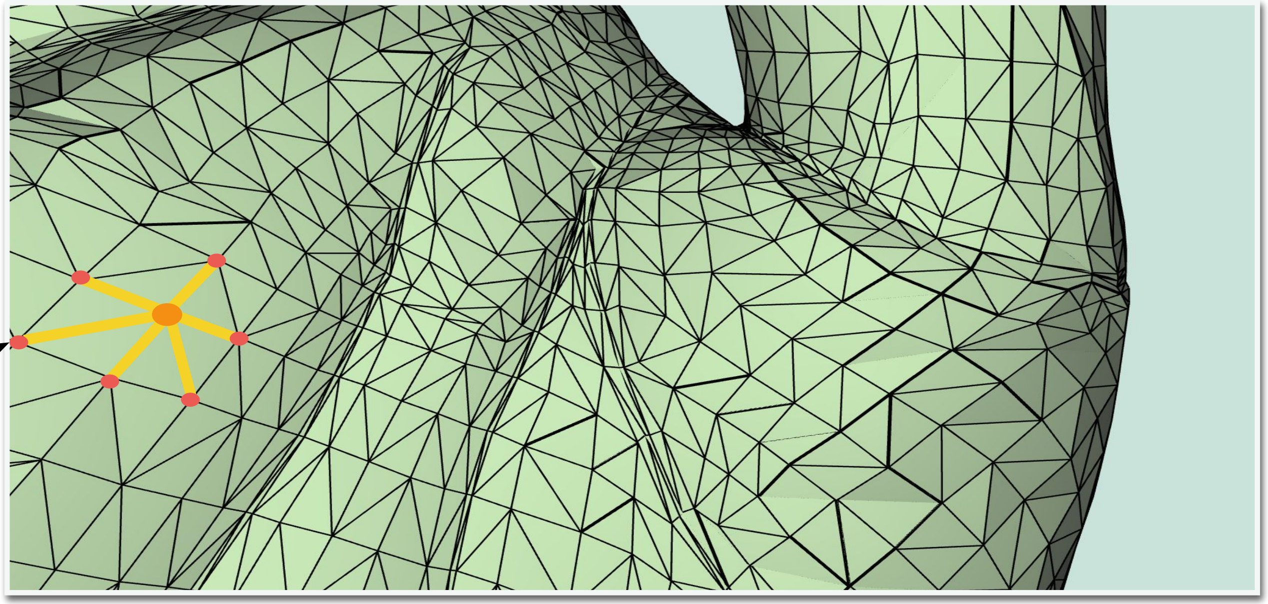
Meshes

- Meshes can be quite dense



Meshes

- How to access adjacency information quickly?



One - Ring Neighborhood

Half-Edge Data Structure

Half Edge	Vertex	Face
Vertex	Position	Half-Edge
Opposite Half-Edge	Outgoing Half-Edge	…
Face	…	
Next Half-Edge		

Half-Edge Data Structure

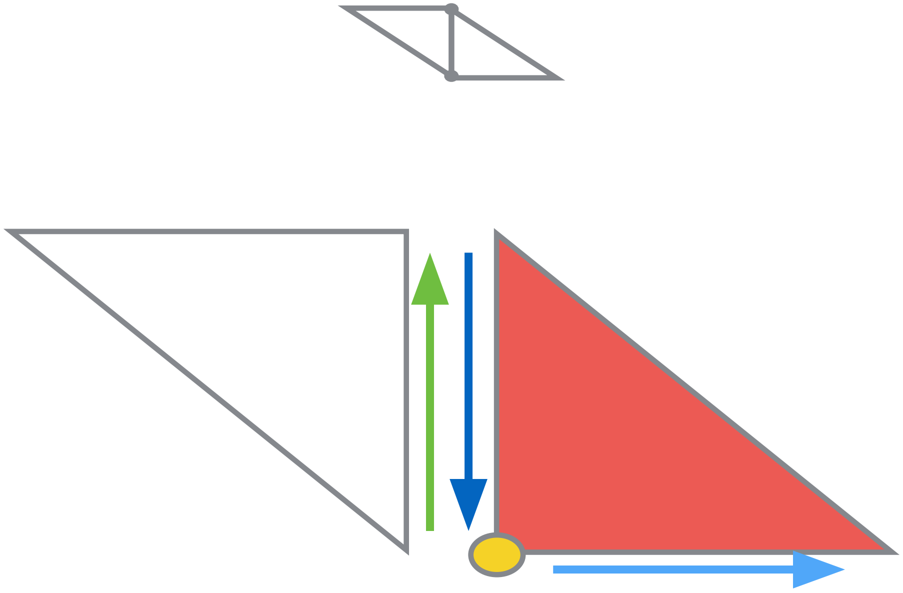
Half-Edge

Vertex

Opposite Half-Edge

Face

Next Half-Edge



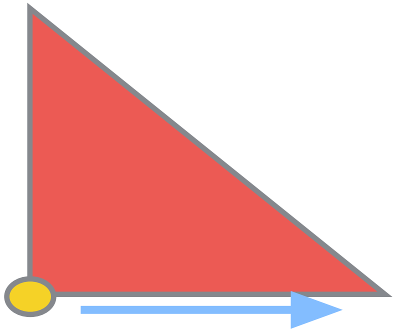
Half-Edge Data Structure

Vertex

Location

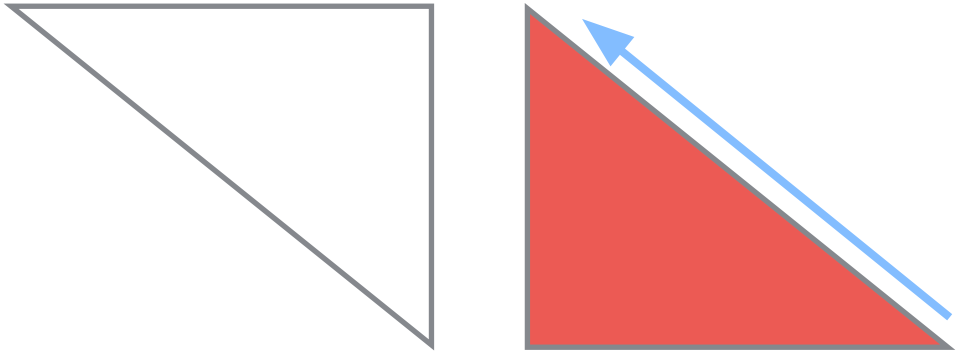
Outgoing
Half-Edge

…

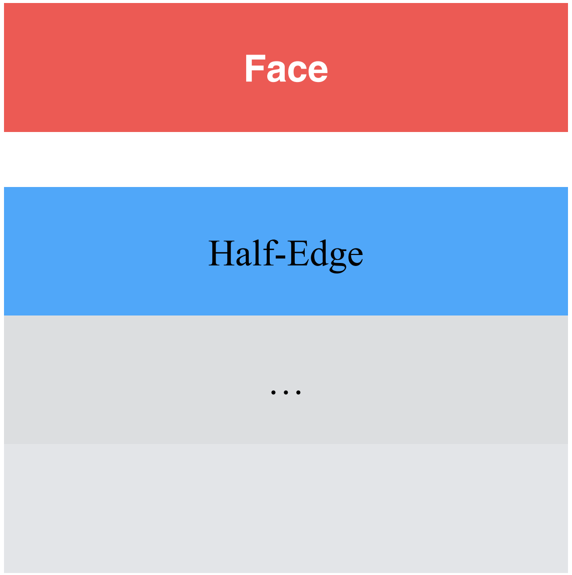


One of the two outgoing edges
will be used

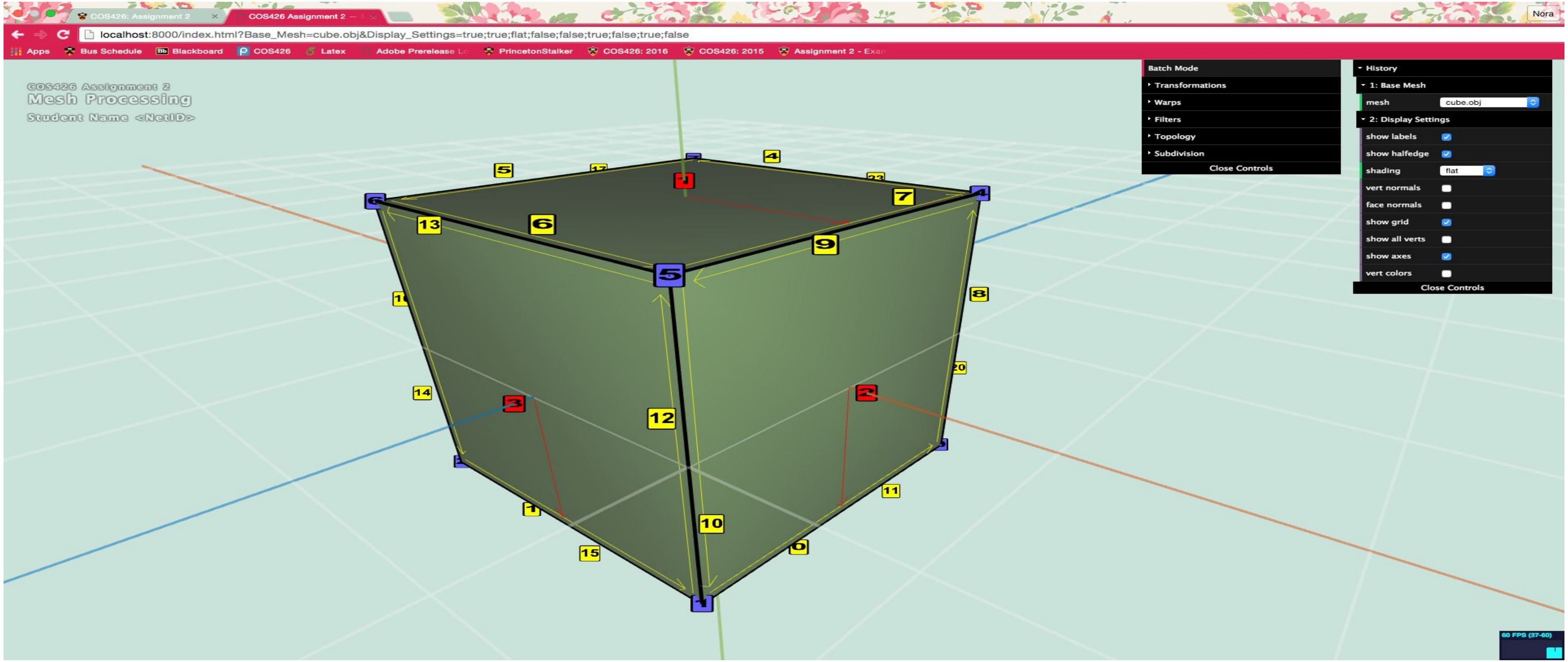
Half-Edge Data Structure



One of the three edges
will be used

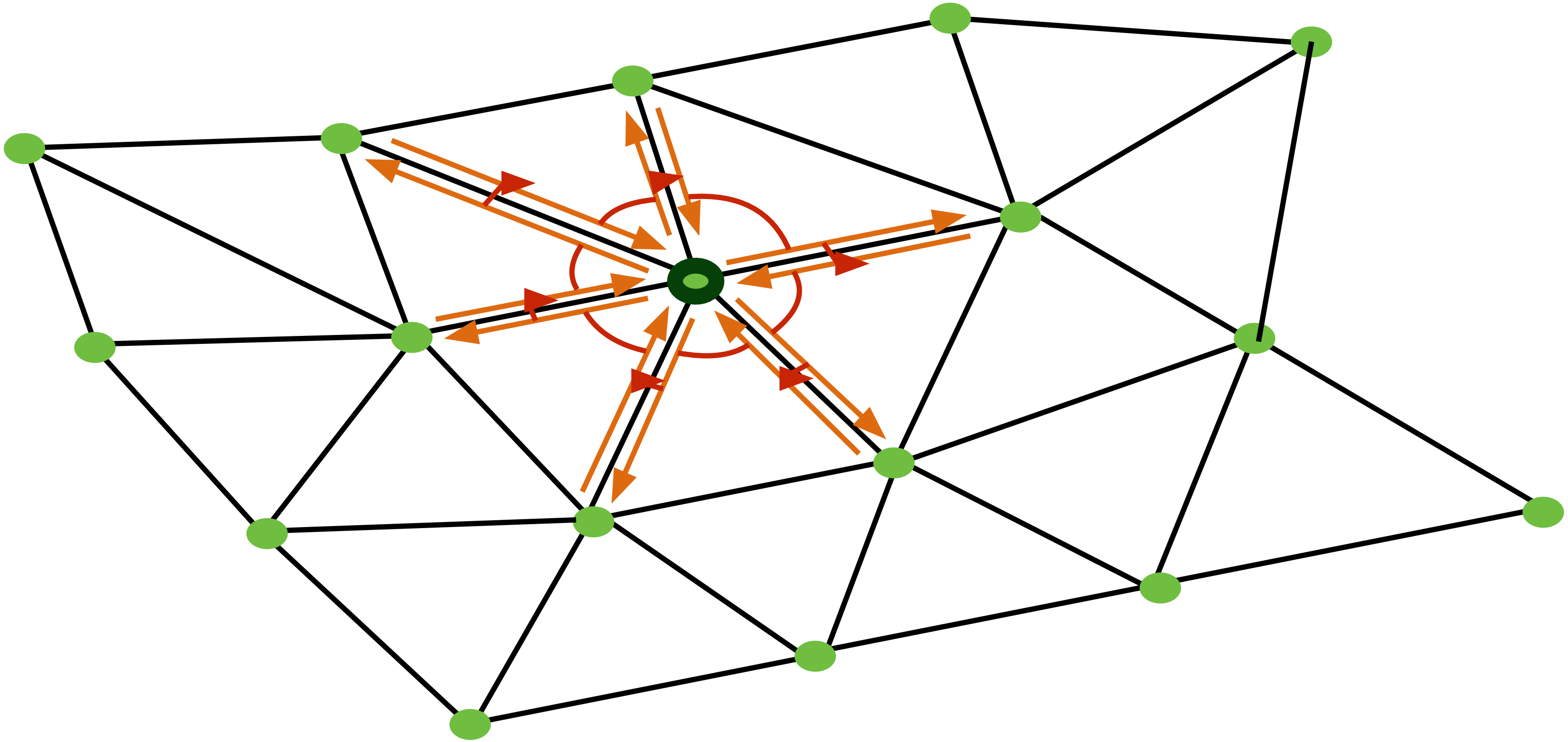


Half-Edge Visualization



Exercise: vertex traversal

- How to get one-ring neighbors?



Traversal

- How to get one-ring neighbors?

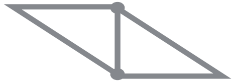
Half-Edge

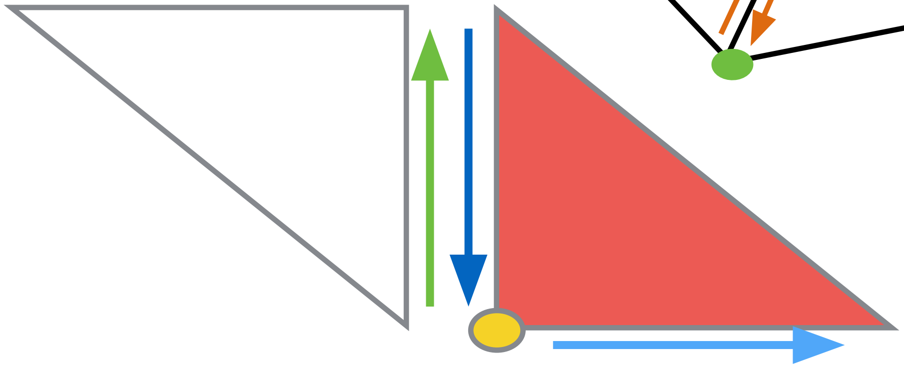
Vertex

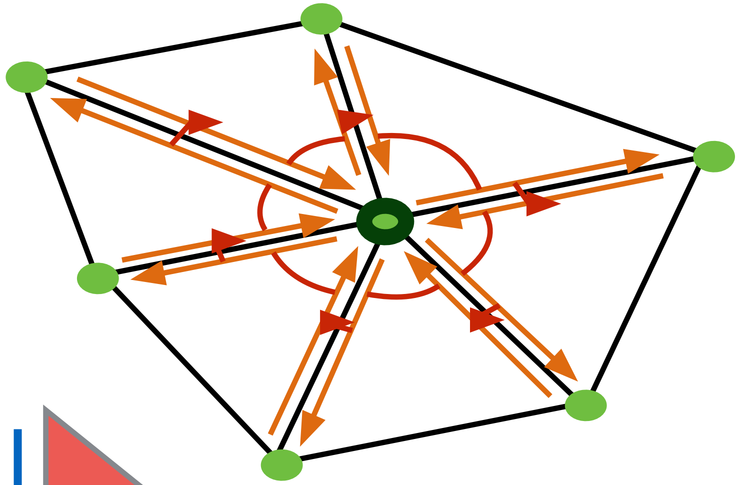
Opposite
Half-Edge

Face

Next
Half-Edge



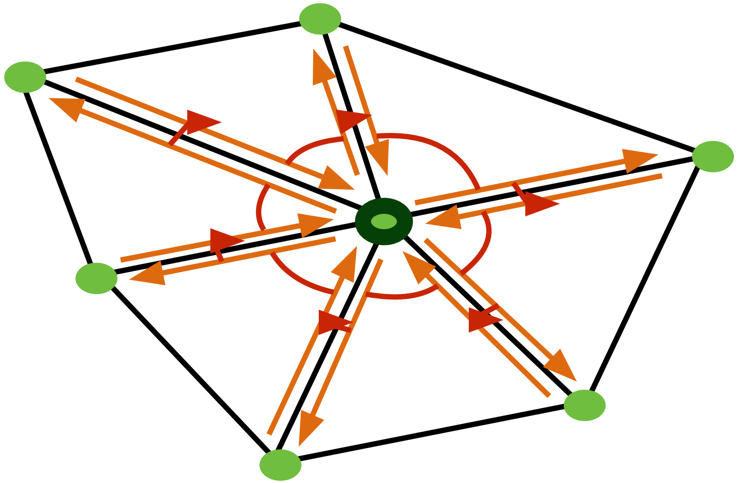




Traversal

- How to get one-ring neighbors?

```
original_he = vertex.he;
current = original_he;
do {
   // do something with data
   current = he.opposite.next;
} while ( he != original_he)
```



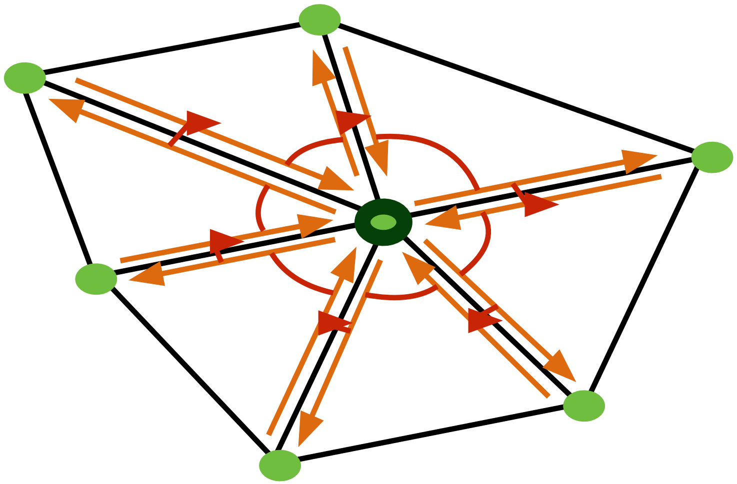
- Assignment will ask you for other kind of adjacency queries
  - Vertices around Face, Faces around Vertex etc.

Traversal

- Vertex Normals are defined as weighted average of adjacent faces (weighted by face area)

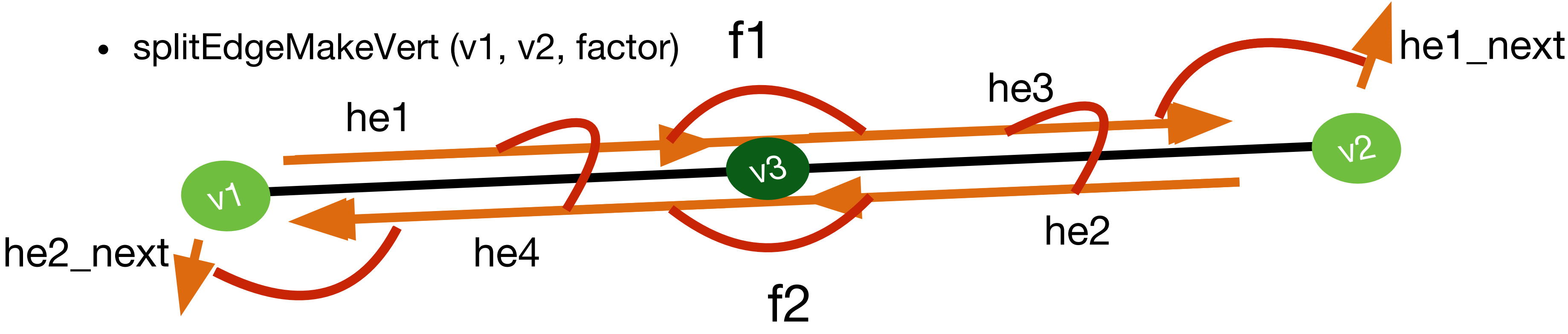
- How would you compute vertex normals given per face normal and area?

Half-Edge
Vertex
Opposite Half-Edge
Face
Next Half-Edge



Data Structure Modification

- splitEdgeMakeVert (v1, v2, factor)

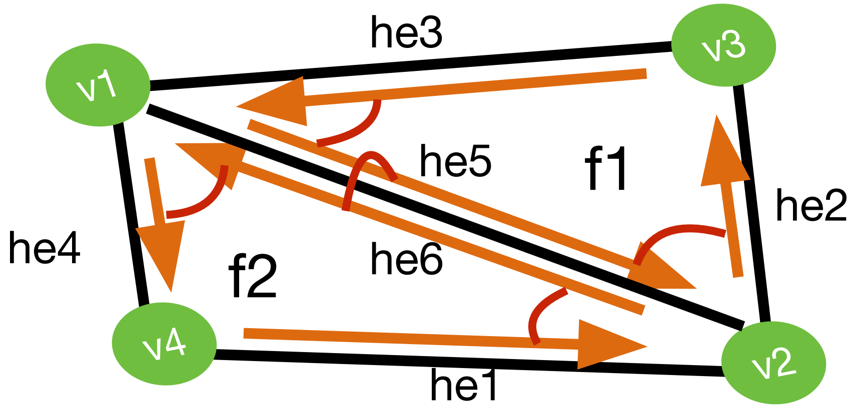



```
v3 = addVertex( weightedAvgPos(v1, v2, factor) );
he1.vertex = v3;
he2.vertex = v3;
he3 = addHalfEdge( v3, v2, f1 );
he4 = addHalfEdge( v3, v1, f2 );
he1.next = he3;
he2.next = he4;
```

```
he3.next = he1_next;
he4.next = he2_next;
he1.opposite = he4;
he4.opposite = he1;
he2.opposite = he3;
he3.opposite = he2;
```

Data Structure Modification

- splitFaceMakeEdge (f, v1, v2, vertOnF, switchFaces)



f2 = addFace();

he5 = addHalfEdge(v1, v2, f1);
he6 = addHalfEdge(v2, v1, f2);
he5.opposite = he6;
he6.opposite = he5;

he5.next = he2;
he3.next = he5;
he1.next = he6;
he6.next = he4;
f1.halfedge = he5;
f2.halfedge = he6;

Remember to re-link he4 and he1 to point to f2

Data Structure Modification

- How would you go about subdividing a quad face?
  - You're given split edge and split face
  - Just use those - guaranteed validity of dataset after use!
- Part of the assignment
  - Think about it during tomorrow's class!