Lecture 3
Half-edge Data Structure Review, Geometry of Curves and Surfaces (I)

Overview

- Quick review of triangle mesh representation and halfedge data structure
- Some exercise
- Basic Geometry of Curves and Surfaces

Halfedge Data Structure Representation

- Why do we need it?
  - Compared with using the vertex table + face table directly?
- Incidence information of the connectivity is stored as a big network indexed by the halfedges :
  - Each face has how many halfedges? How many halfedge pointers does a face keep?
  - Each edge has how many halfedges? How many halfedge pointers does an edge keep?
  - Each vertex has how many halfedges? How many halfedge pointers does a vertex keep?
  - Each halfedge has: next(), prev(), target(), source(), face(), edge(), twin()…

Using Halfedge Data Structure (1)

- Examples:
- 1. How to check whether a face is on the boundary?
- 2. How to check whether an edge is on the boundary?
- 3. How to check whether a vertex is on the boundary?
  1) How to find a "most-clockwise-in-halfedge" of a boundary vertex? (How to rotate a halfedge he0 clockwise (clw) about its target?)
  2) How to find a "most-clockwise-out-halfedge" of a boundary vertex?
  3) How to find a "most-counterclockwise-in-halfedge" of a boundary vertex?
  4) How to find a "most-counterclockwise-out-halfedge" of a boundary vertex?

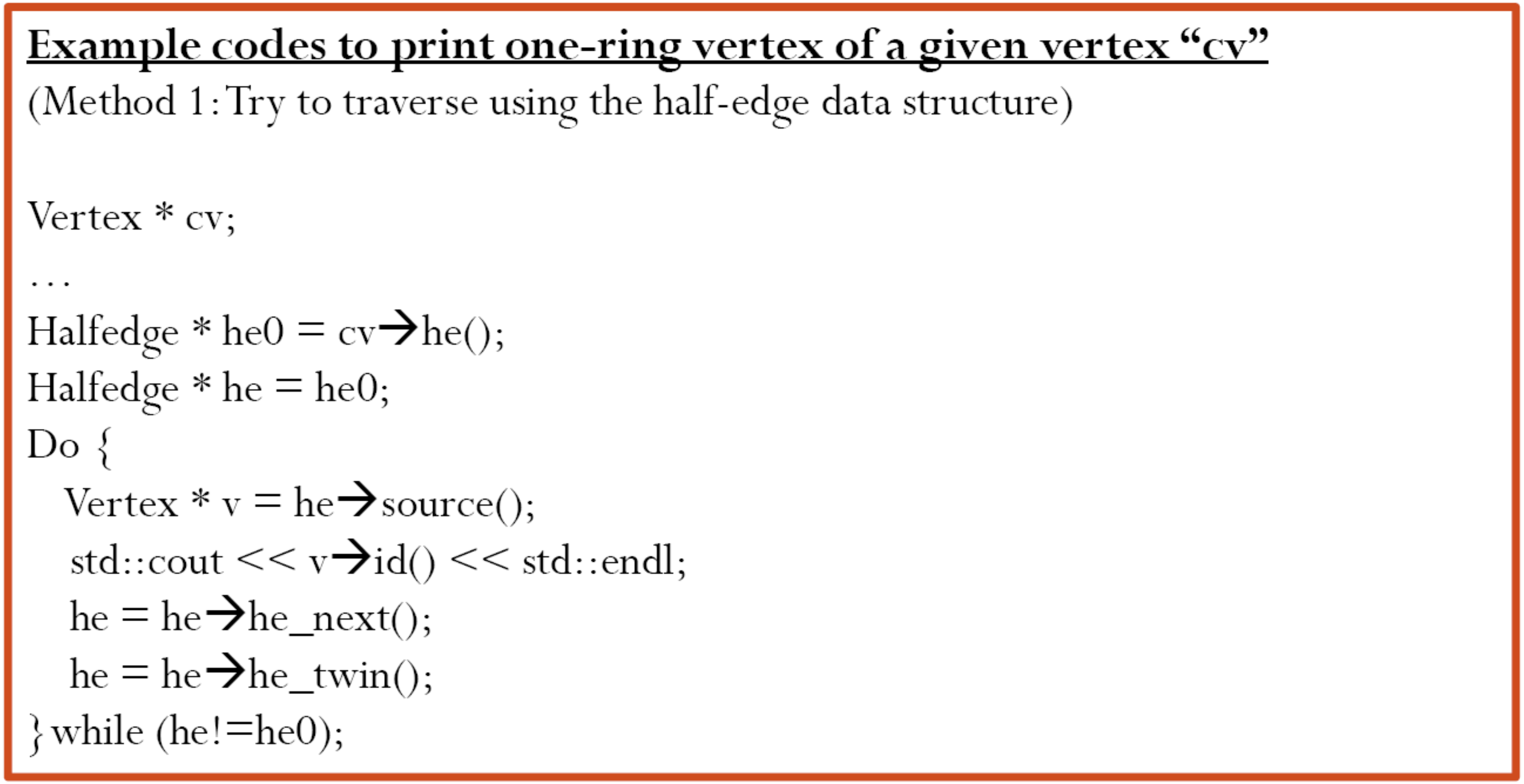
Using Halfedge Data Structure (2)

Solution for 3. 1):

```
Halfedge * MostCLWHalfedgeAboutTarget(Halfedge * he0){
        Halfedge * he1=he0;                    // the result is stored in he1
        Halfedge * nhe = he1->next()->twin();
        Do while (nhe & nhe!=he0) {
            he1=nhe;
            nhe= nhe->next()->twin();
        }
        Return he1;
}
```

Using Halfedge Data Structure (3)

Example 4. How to find the one-ring neighboring vertices of a vertex v?



Example codes to print one-ring vertex of a given vertex "cv"

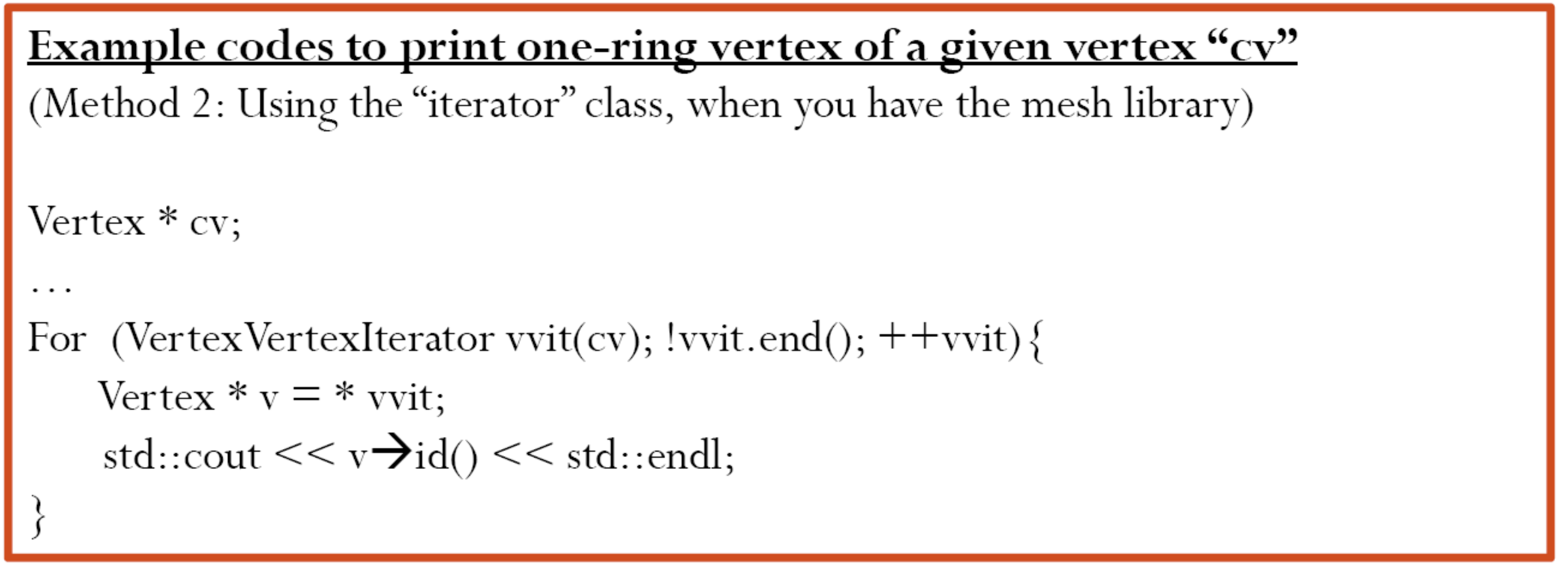
(Method 1: Try to traverse using the half-edge data structure)

```
Vertex * cv;
…
Halfedge * he0 = cv→he();
Halfedge * he = he0;
Do {
   Vertex * v = he→source();
   std::cout << v→id() << std::endl;
   he = he→he_next();
   he = he→he_twin();
}while (he!=he0);
```

Using Halfedge Data Structure (4)

Example 4. How to find the one-ring neighboring vertices of a vertex v?

(the previous method has been implemented in the iterator classes.)



<u>Example codes to print one-ring vertex of a given vertex "cv"</u>

(Method 2: Using the "iterator" class, when you have the mesh library)

```
Vertex * cv;
…
For  (VertexVertexIterator vvit(cv); !vvit.end(); ++vvit){
      Vertex * v = * vvit;
      std::cout << v→id() << std::endl;
}
```

Using Halfedge Data Structure (5)

Example 5. How to Travel along the boundary loop?

Example codes to traverse the boundary

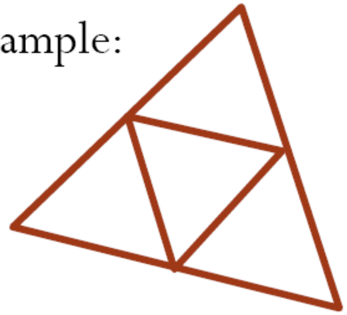
(given a boundary halfedge he0, print all following halfedges in the boundary loop):

```
Halfedge * he0; // suppose it is a boundary halfedge
Halfedge * he; //the current boundary halfedge to print
Do {
    std::cout << he << std::endl;
    he=MostCLWHalfedgeAboutTarget(he);
    he=he->next();
} while (he!=he0)
```

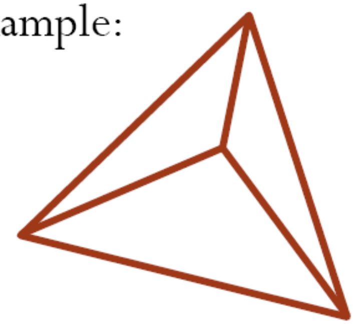
Using Halfedge Data Structure (6)

More Complex Example: How to do subdivision:

One example:



Another example:



to split a face (type 2)

Face * f0;   //the face we want to split

…

-Create a new vertex nv ← the mass center of f0

-Create three new edges, six new halfedges

-Update half-edges, forming three cycles

-Create three new faces, link edges, halfedges accordingly

-Delete the original face