COS 426
Computer Graphics
Princeton University

Vladimir Kim (Vova)

Feb 25, 2011

Assignment 1

- Submission guidelines!
  - http://www.cs.princeton.edu/courses/archive/spr11/cos426/submission.pdf

Mesh Processing

- **Half Edge representation**
  - Load shape
  - Find all faces adjacent to a vertex
  - Collapse edge
  - Flip Edge

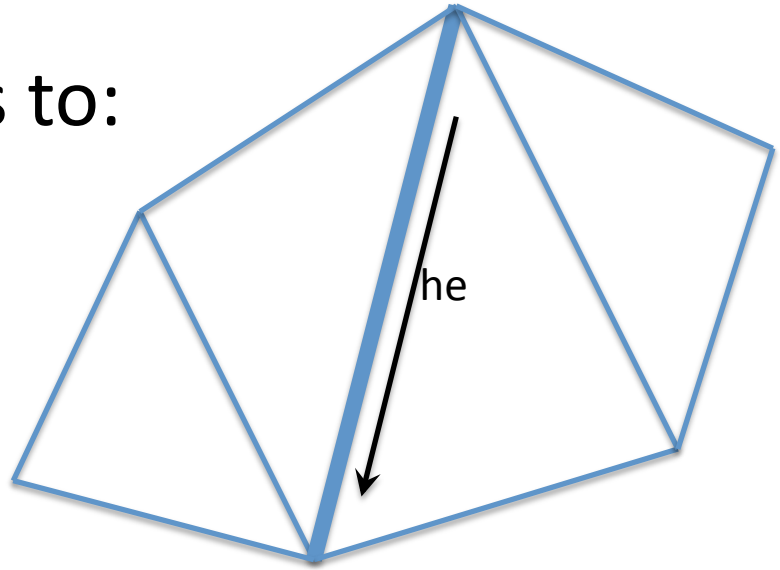
Half Edge

- http://groups.csail.mit.edu/graphics/classes/6.838/S98/meetings/m4/IV.HalfEdge.html

- Mesh Represented by:
  - list of half edges (|HE|)
  - list of vertices (|V|)
  - list of faces (|F|)

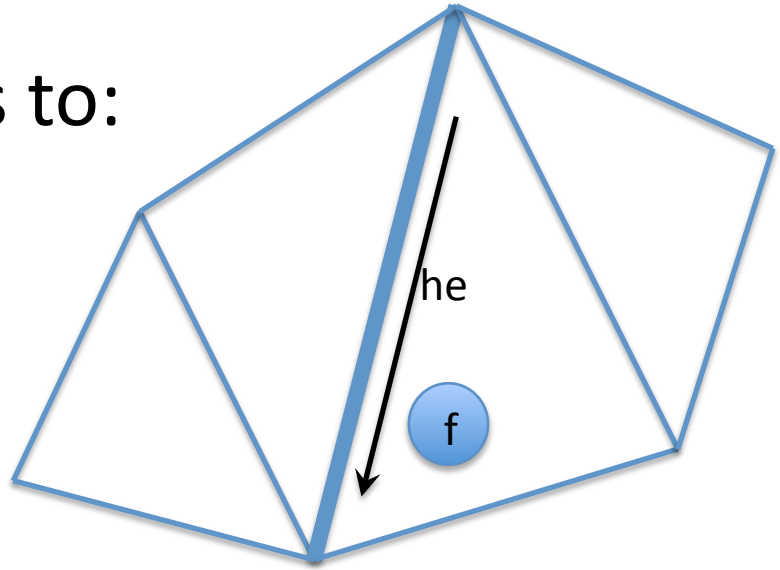
Half Edge

- Half Edge (he) has pointers to:



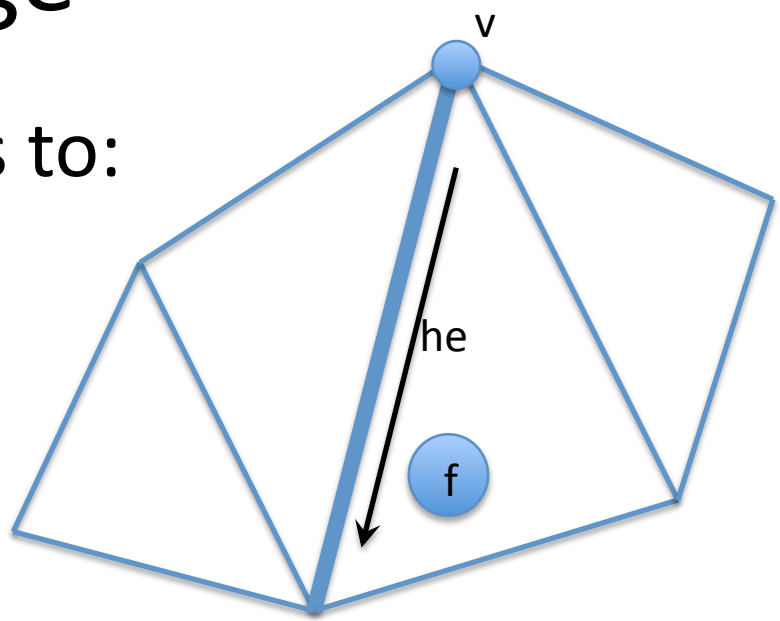
Half Edge

- Half Edge (he) has pointers to:
  - adjacent face f (to the left)



Half Edge

- Half Edge (he) has pointers to:
  - adjacent face f (to the left)
  - source vertex v



Half Edge

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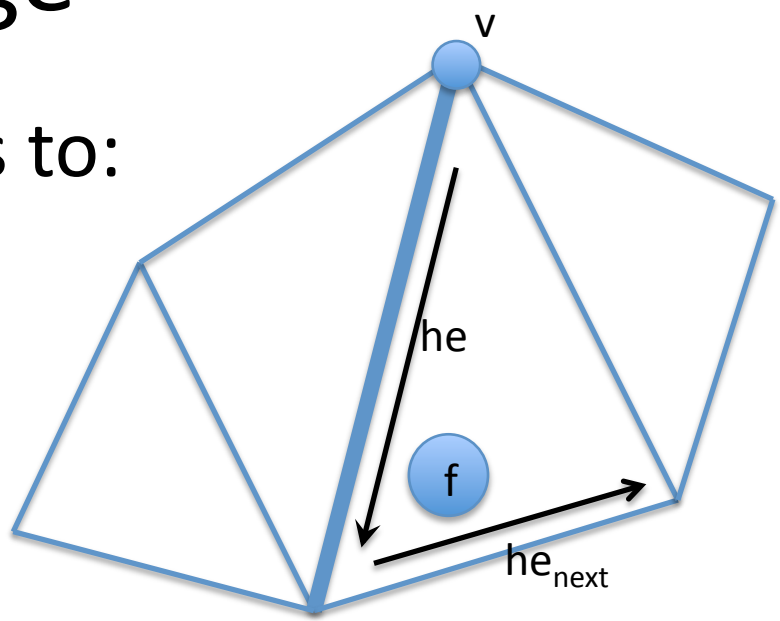
  - next half edge he_{next}



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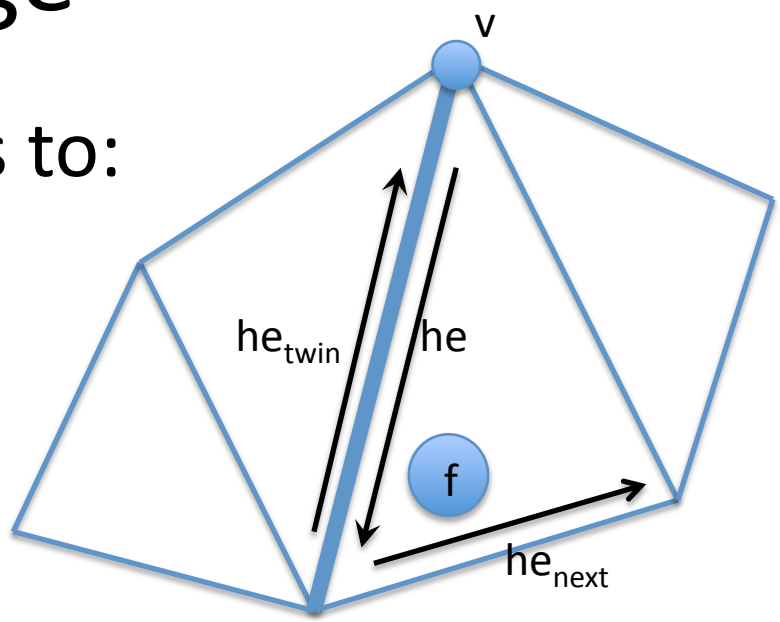

Half Edge

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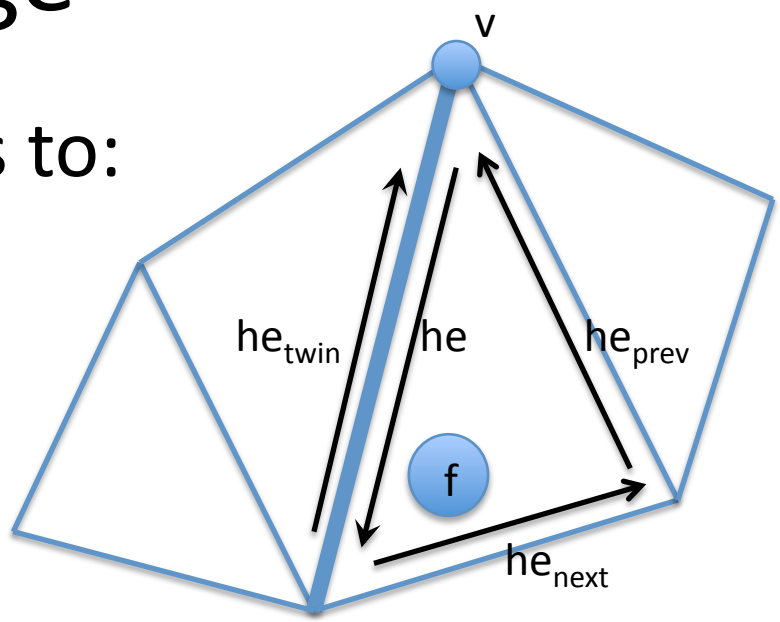
  - (optional) previous half edge he_{prev}
    - Note: for triangles $he_{prev} = he_{next}->he_{next}$



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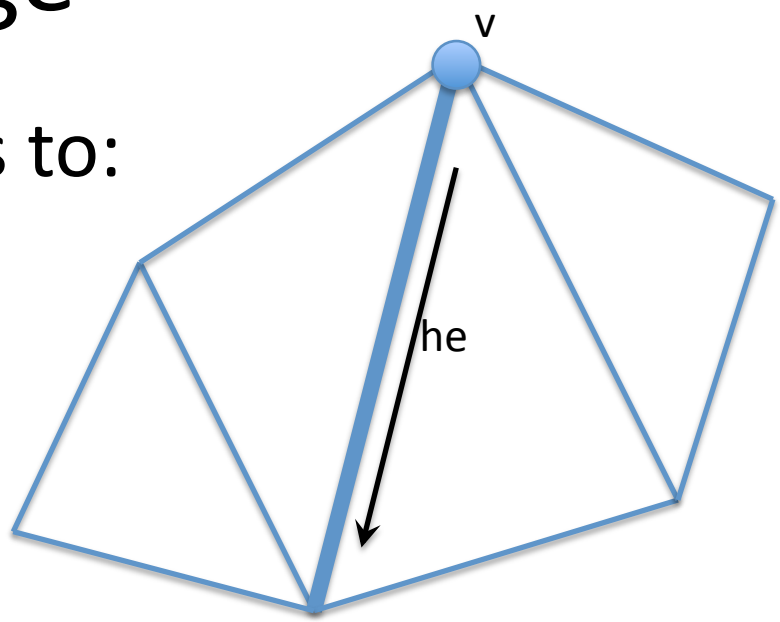

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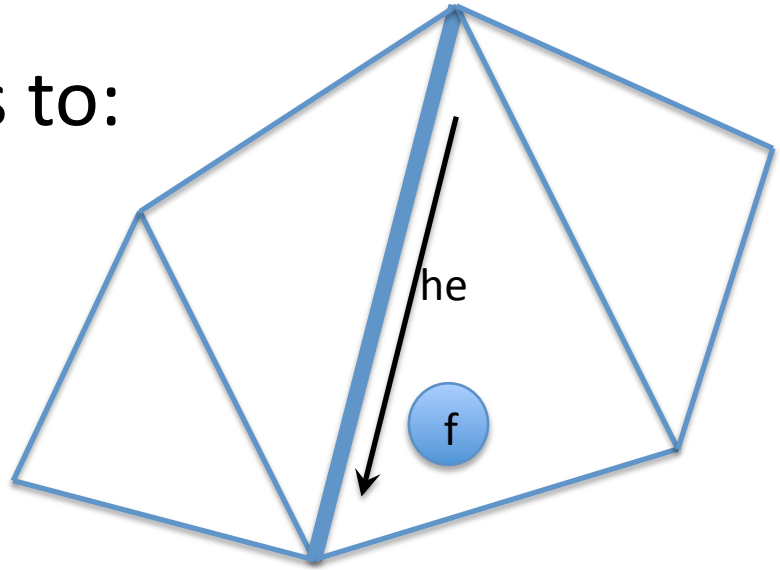
- Vertex v has pointer to
  - an outgoing half edge he
- Face f has pointer to
  - a boundary half edge he



Mesh Processing

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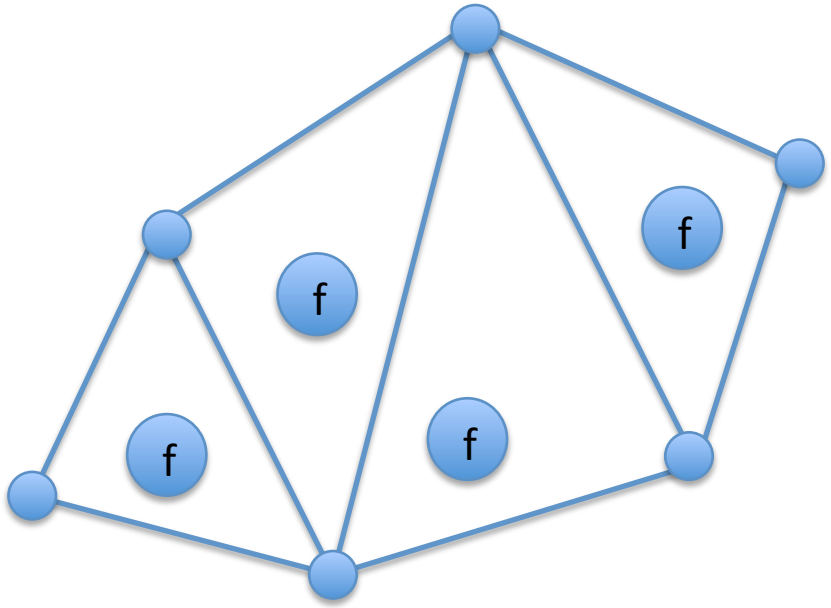
Example Shape

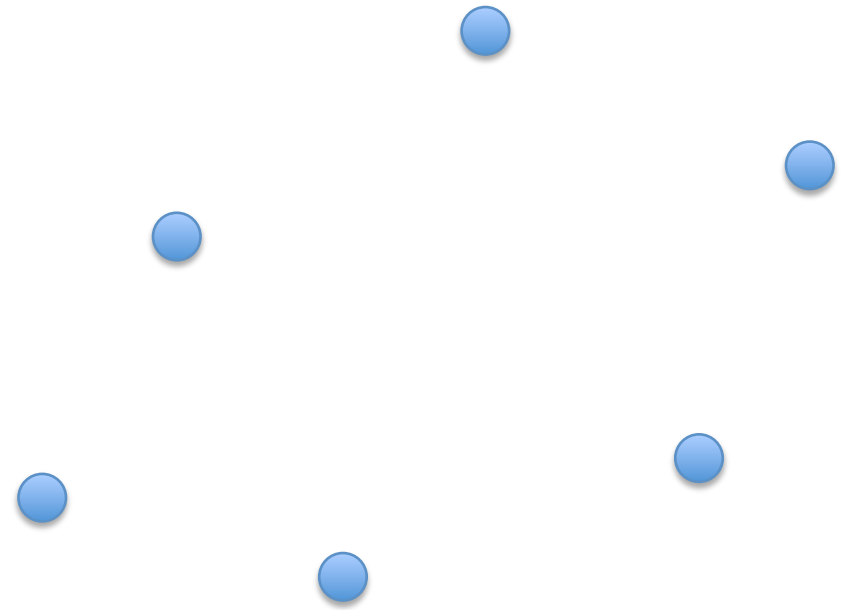
- *.off: vertices + triangles

?



Example Shape

- *.off: vertices + triangles
- Add vertices to the list
  - only coordinates



Example Shape

- *.off: vertices + triangles
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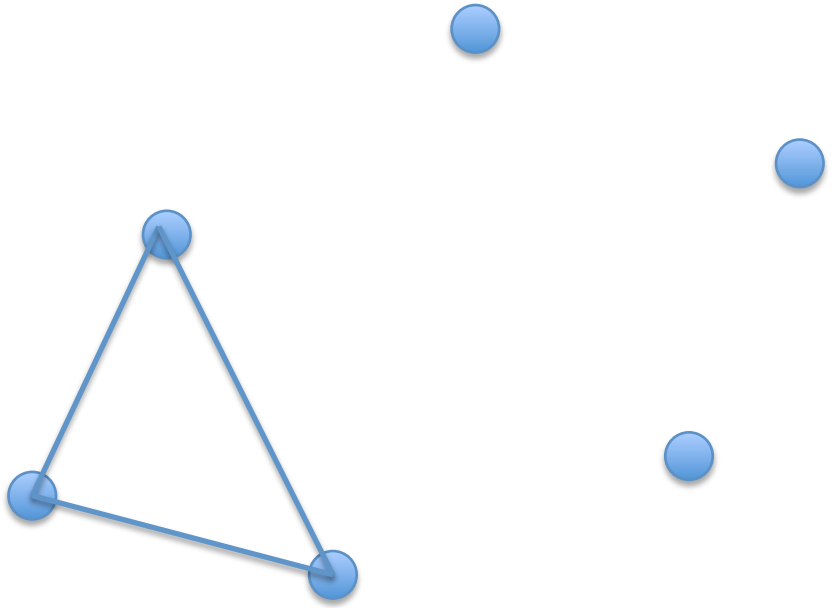
- Add half-edges with faces



Example Shape

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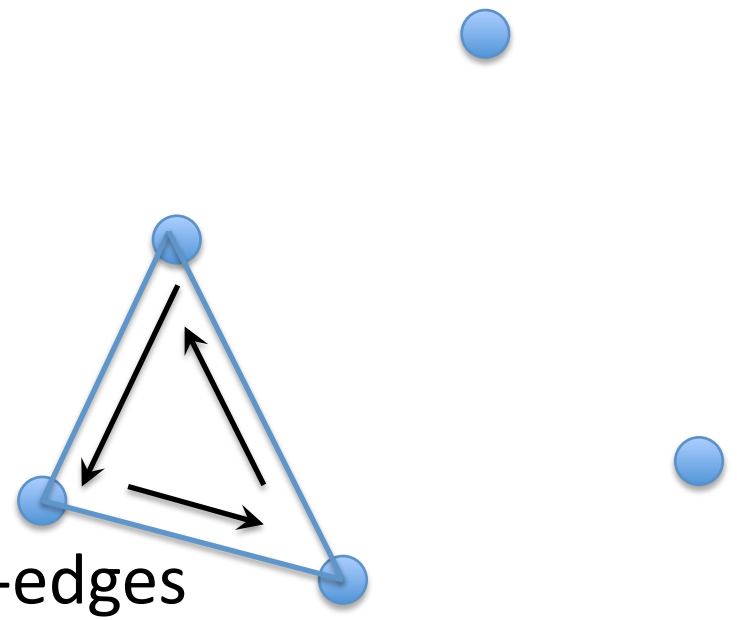

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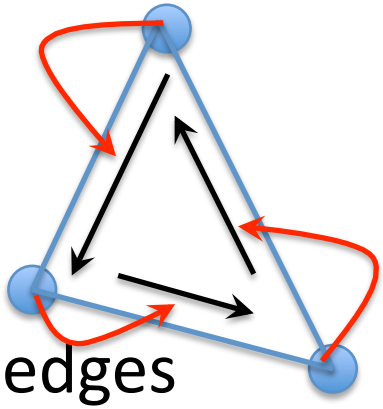

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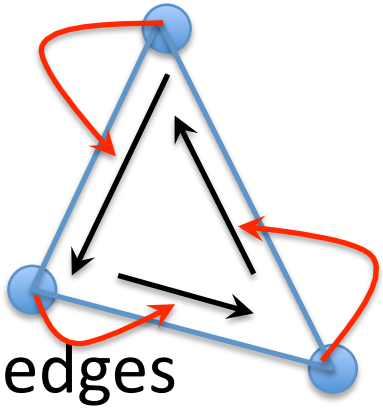

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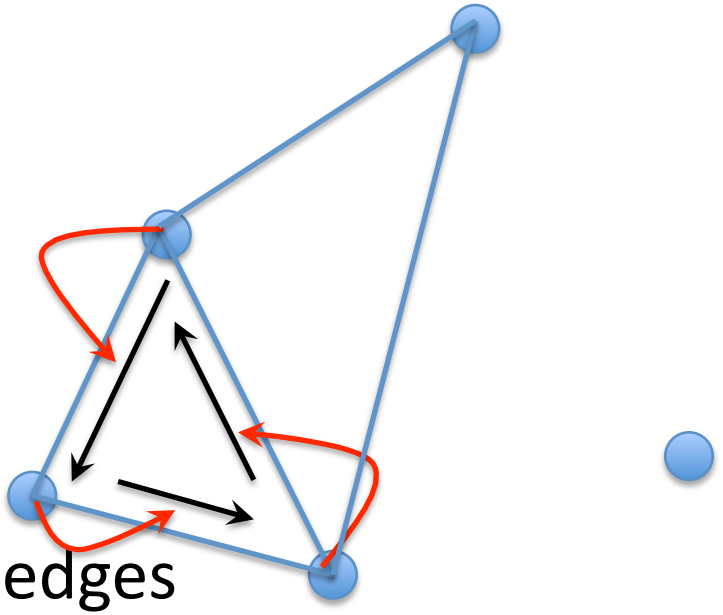

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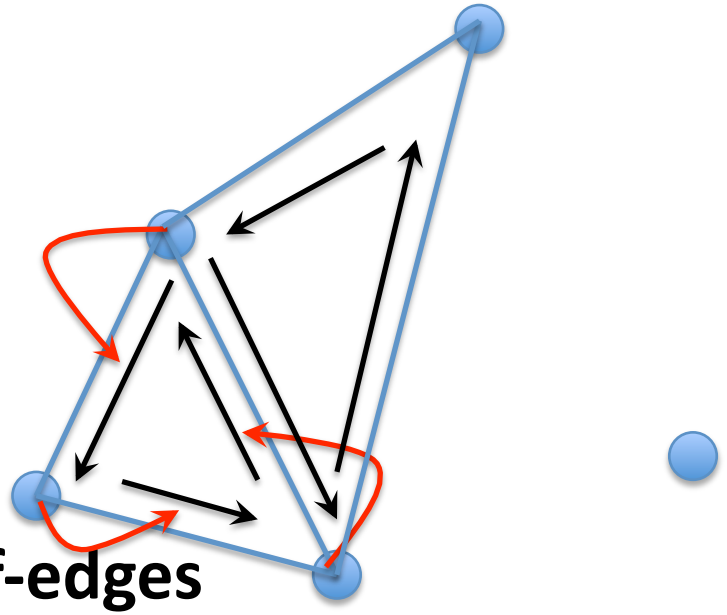

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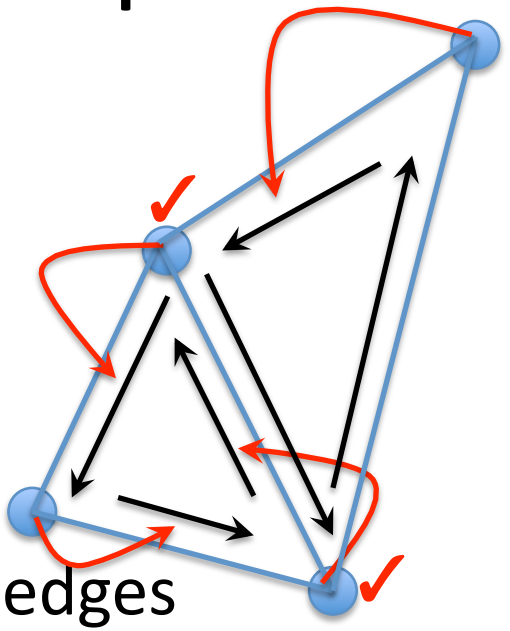

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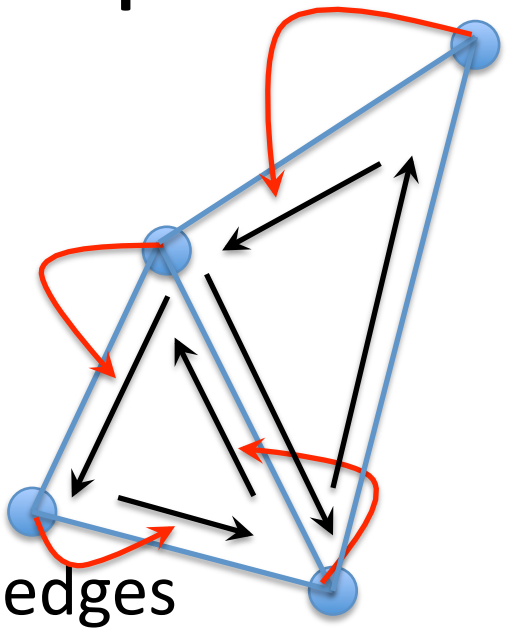

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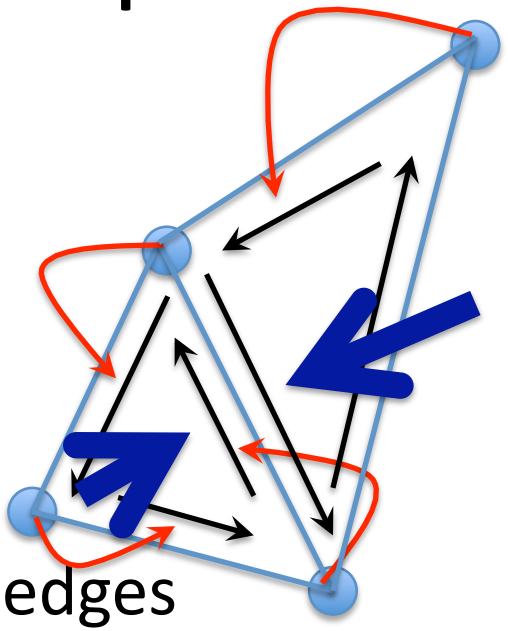

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  - if necessary: update vertex pointers to half edges
  - each half-edge: pointer to ‘next’, pointer to ‘face’
  - face: pointer to one of the inner half-edges
  - **pointer to the ‘twin’ half edge**
    - **use a temporary datastructure – e.g. all edges at each vrtx**

Mesh Processing

- **Half Edge representation**
  - Load shape
  - **Find all faces adjacent to a vertex**
  - Collapse edge
  - Flip Edge

Find Adjacent Faces

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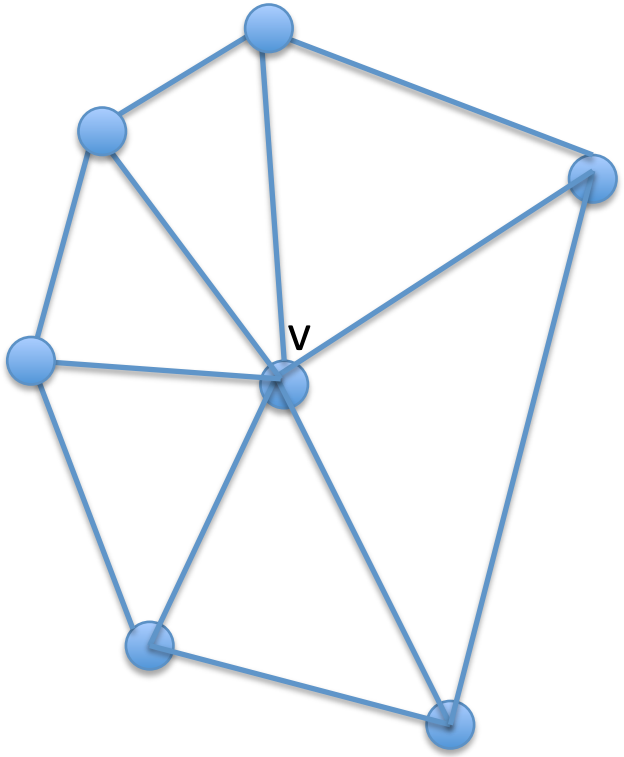
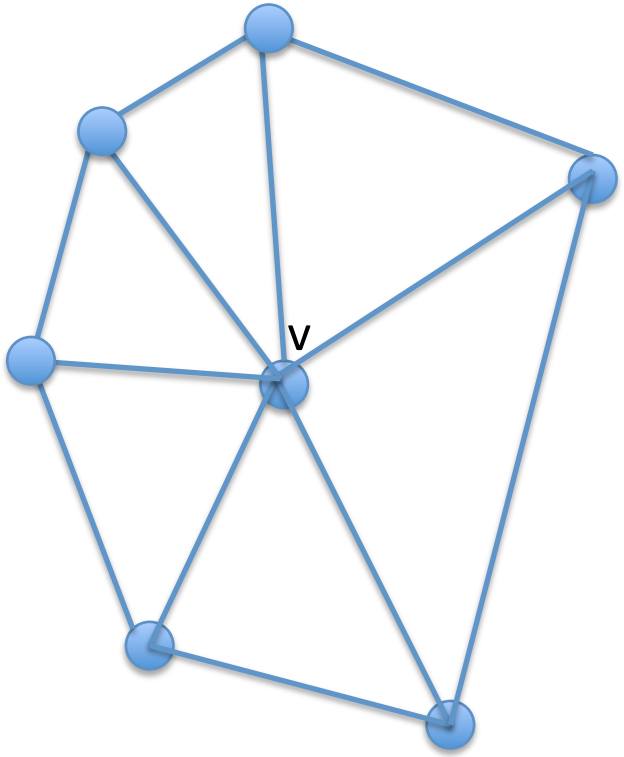


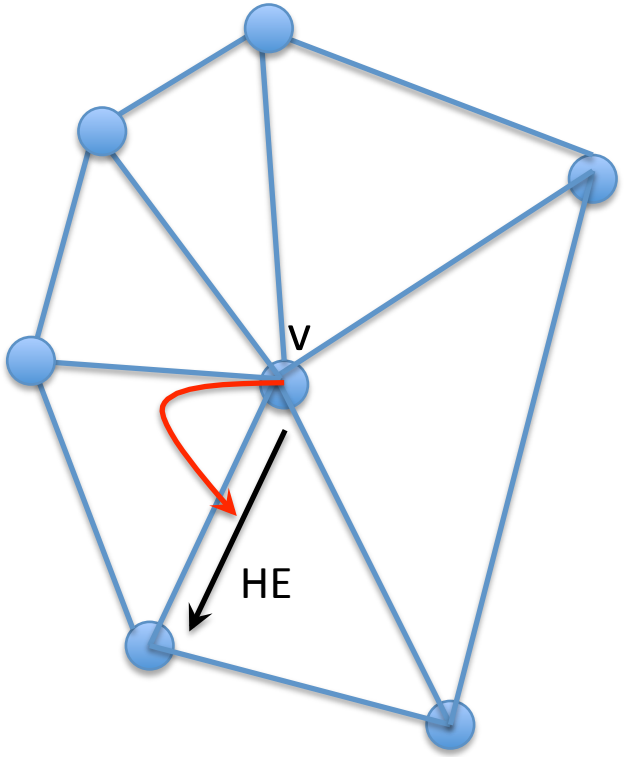
Find Adjacent Faces

- Check all outgoing half edges



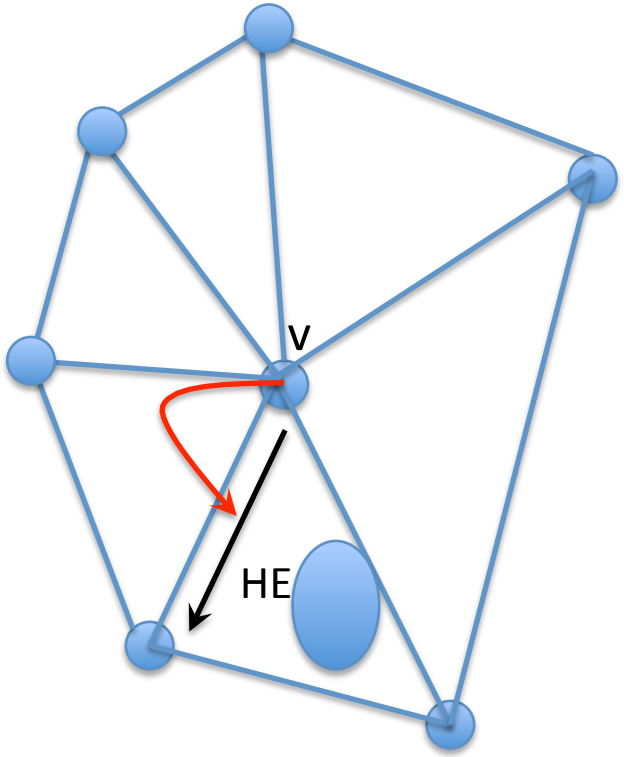
Find Adjacent Faces

- Check all outgoing half edges
  - points to a half edge HE



Find Adjacent Faces

- Check all outgoing half edges
  - points to a half edge HE
  - ADD_FACE(HE)



Find Adjacent Faces

- Check all outgoing half edges
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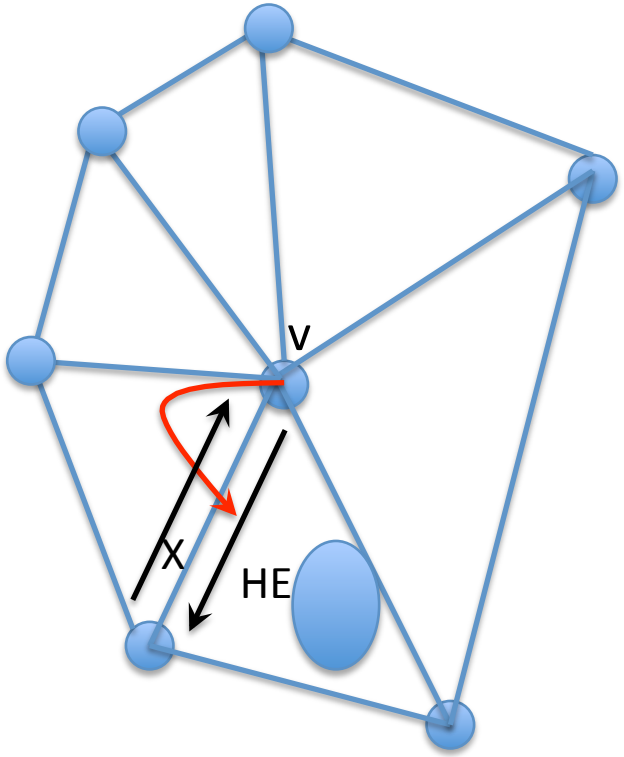
  - ADD_FACE(HE)
  - Iterate:
    - $X=HE_{twin}$



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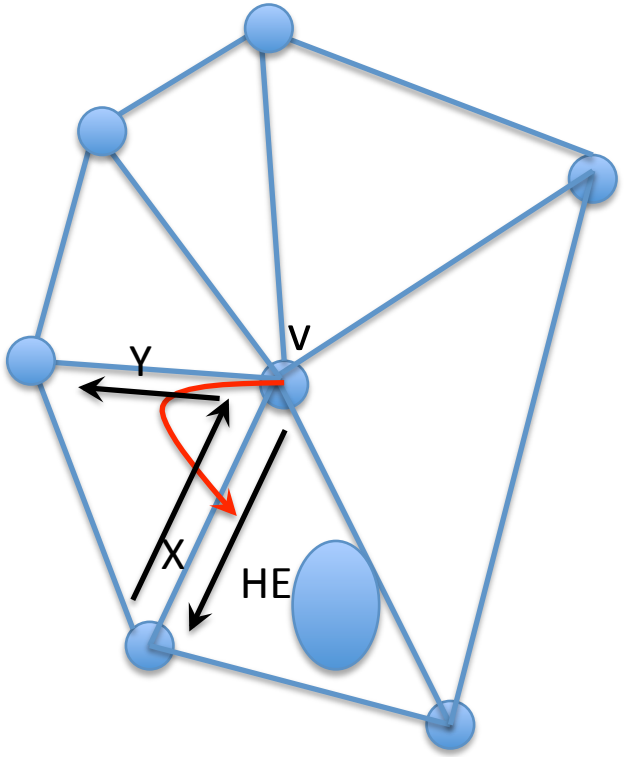

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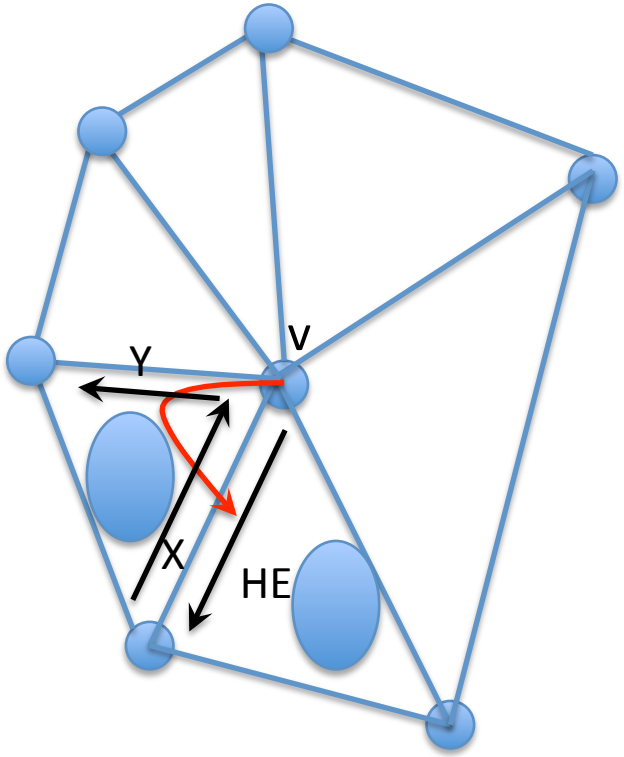

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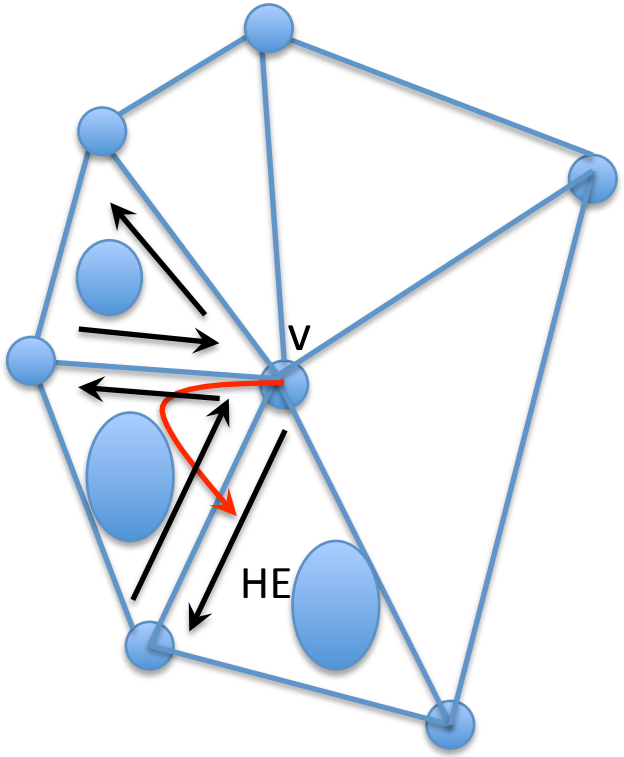

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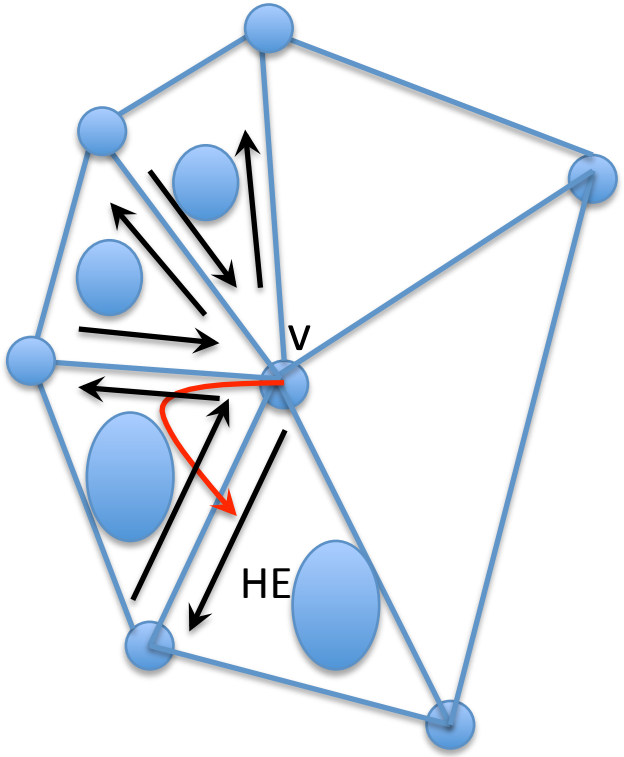

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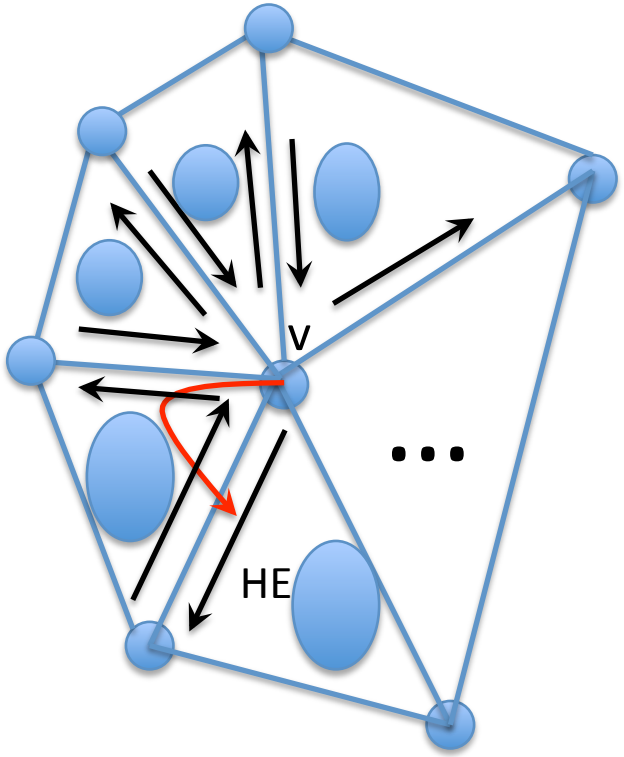

Mesh Processing

- **Half Edge representation**
  - Load shape
  - Find all faces adjacent to a vertex
  - **Collapse edge**
  - Flip Edge

Collapse an Edge

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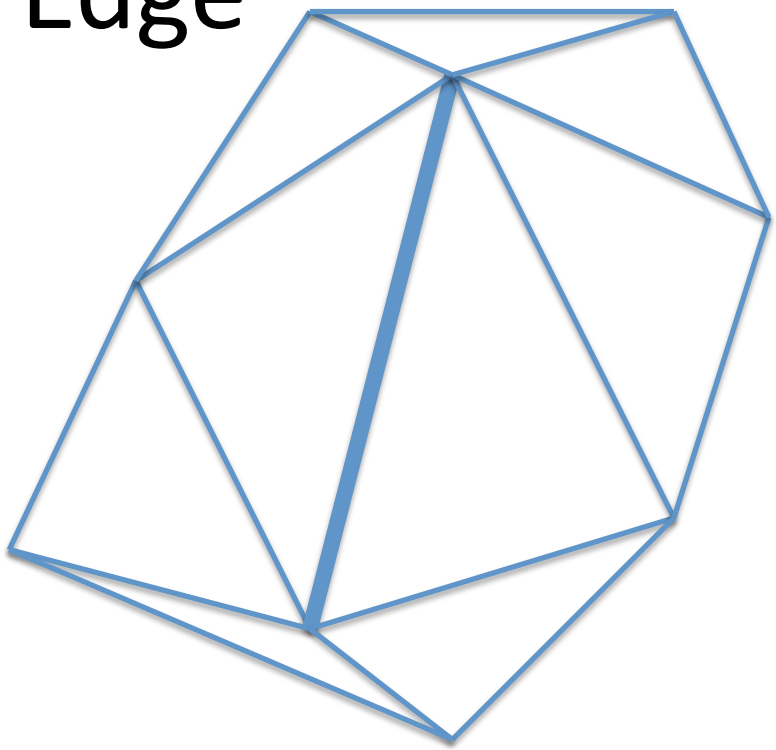
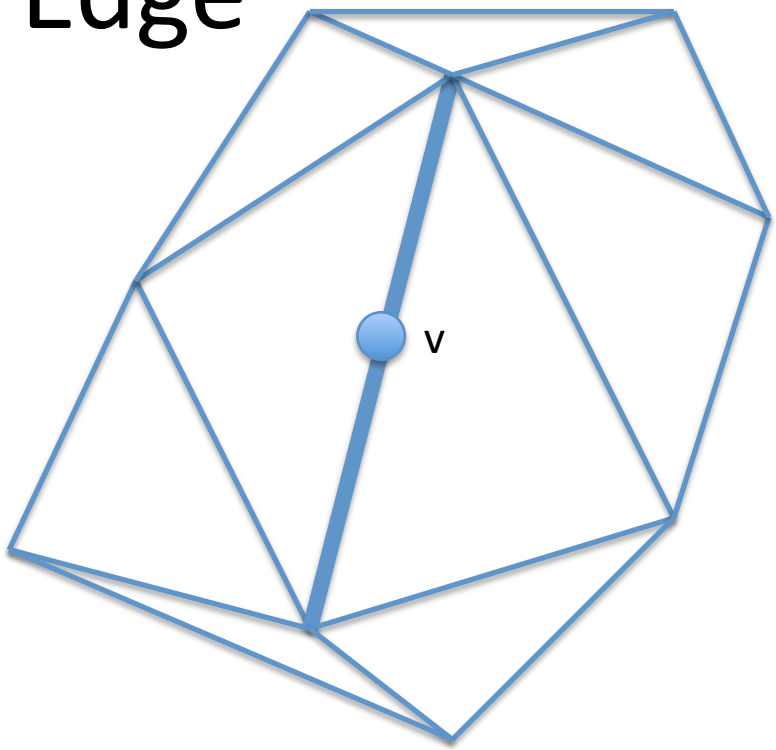


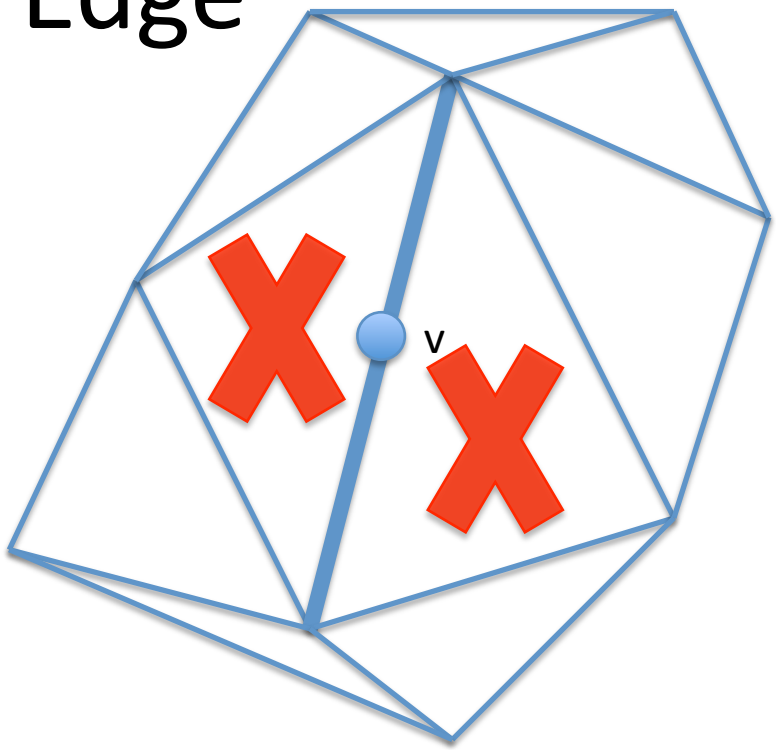
Collapse an Edge

- Create new vertex v



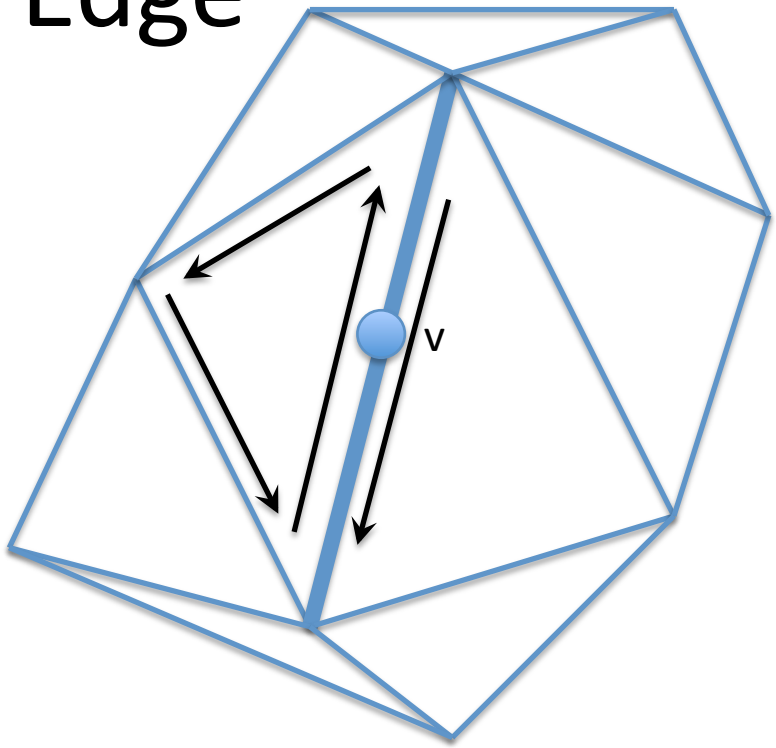
Collapse an Edge

- Create new vertex v
- Remove faces



Collapse an Edge

- Create new vertex v
- Remove faces
- Change ‘twin’ pointers



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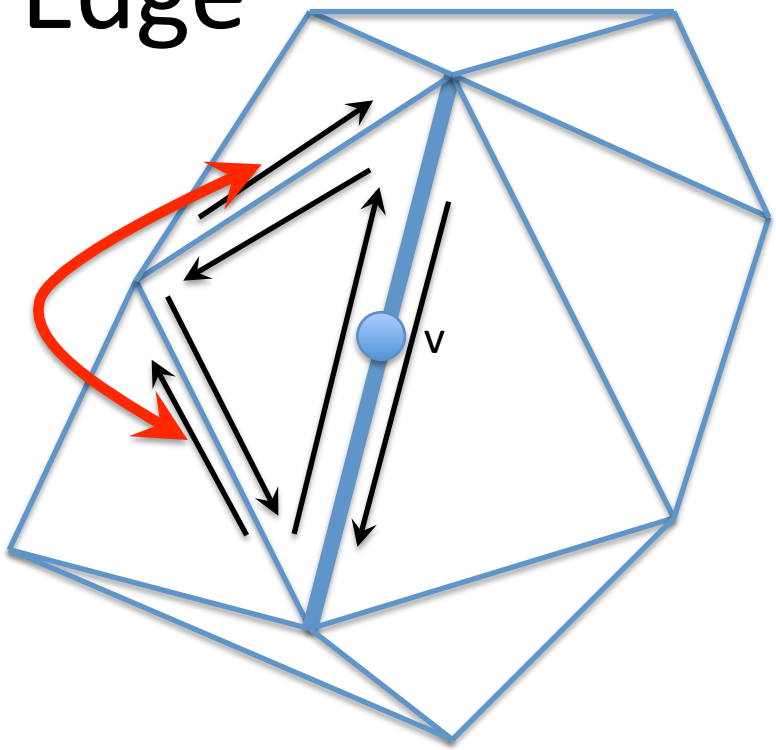

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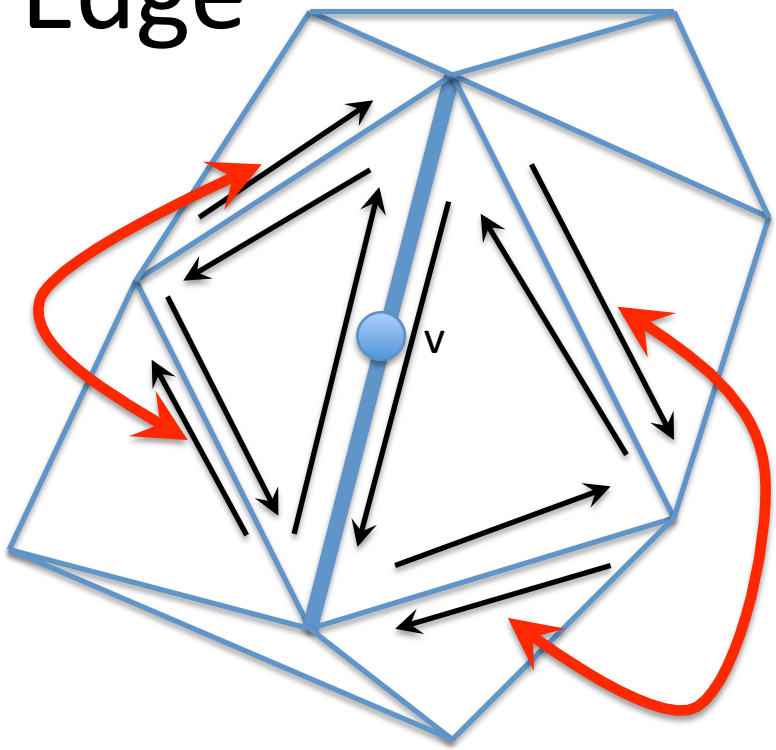
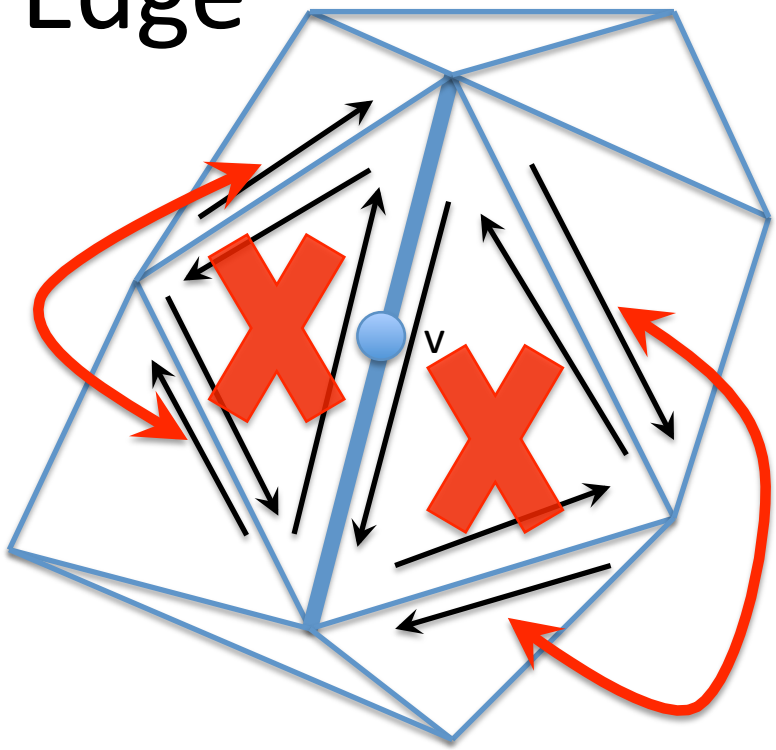


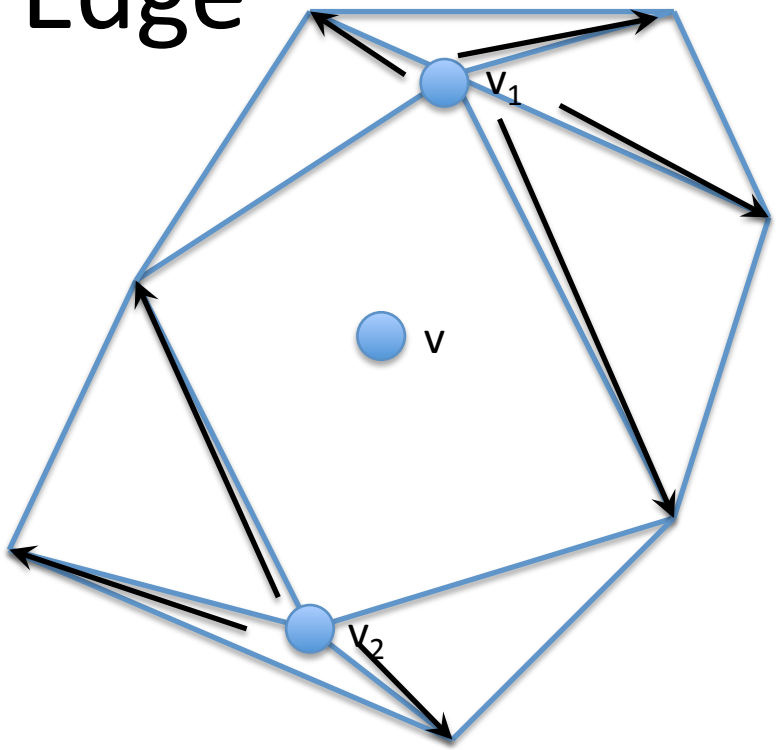
Collapse an Edge

- Create new vertex v
- Remove faces
- Change ‘twin’ pointers
- Remove edges



Collapse an Edge

- Create new vertex v
- Remove faces
- Change ‘twin’ pointers
- Remove edges
- Change pointers to v_1, v_2
  - check outgoing edges



Collapse an Edge

- Create new vertex v
- Remove faces
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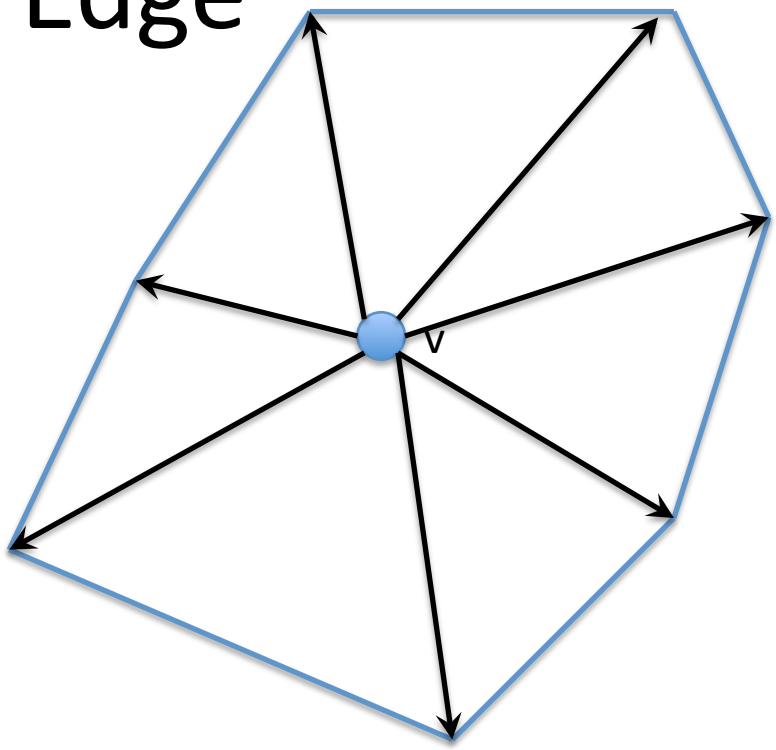
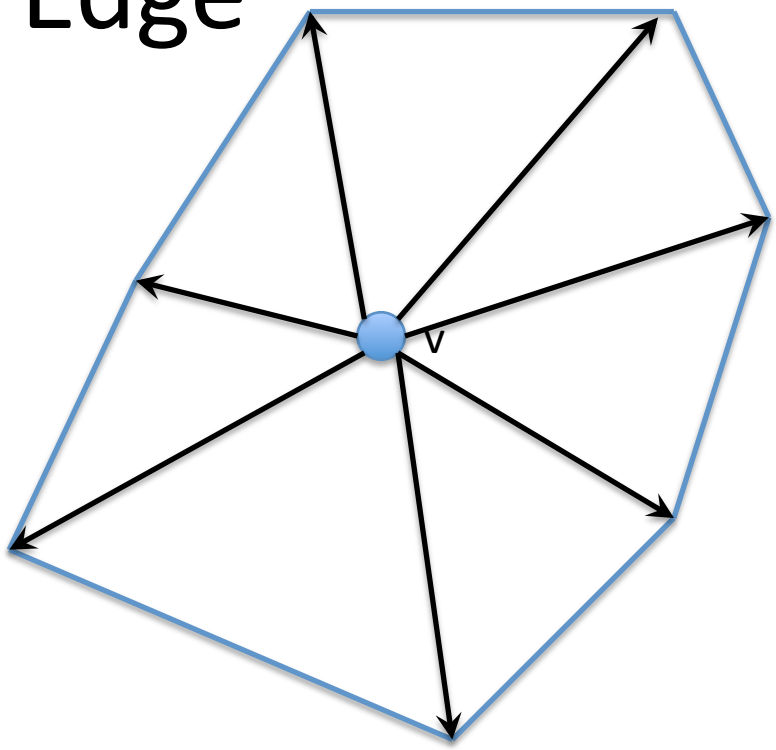
- Remove edges
- Change pointers to v_1, v_2
- Remove v_1, v_2



Collapse an Edge

- Create new vertex v
- Remove faces
- Change ‘twin’ pointers
- Remove edges
- Change pointers to v_1, v_2
- Remove v_1, v_2
- Pick an outgoing edge for v



Mesh Processing

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Flip an Edge

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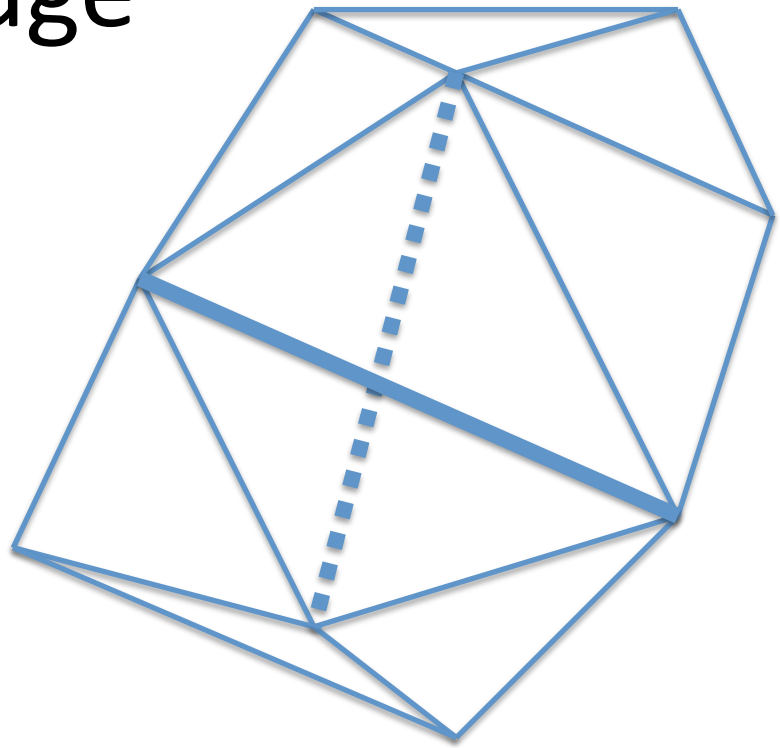
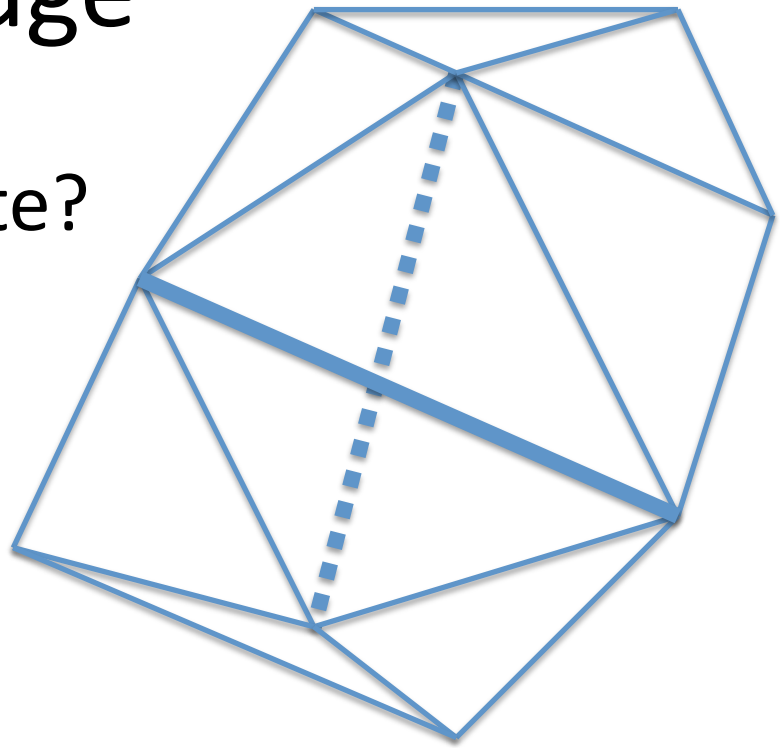


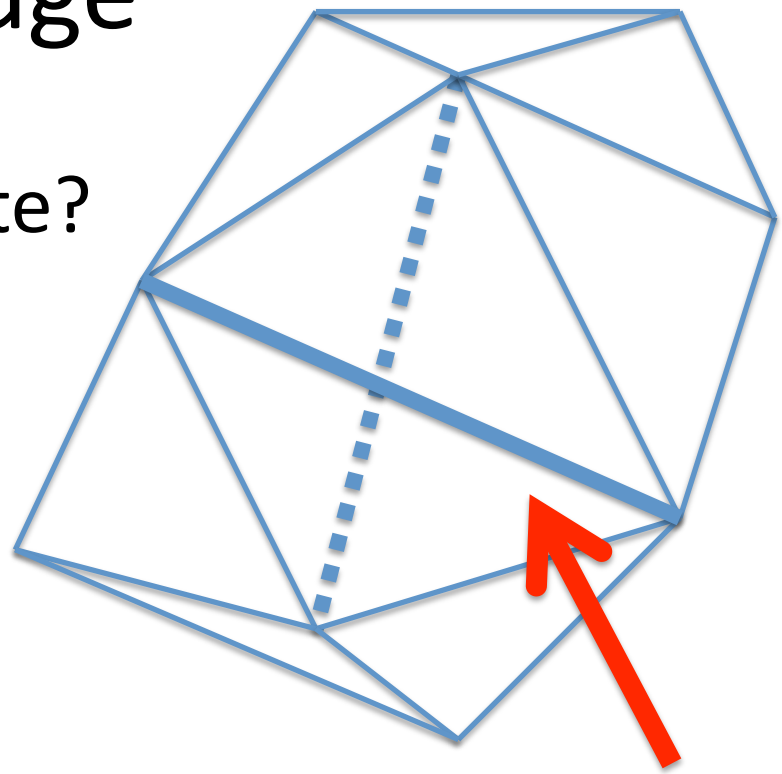
Flip an Edge

- What do we need to update?



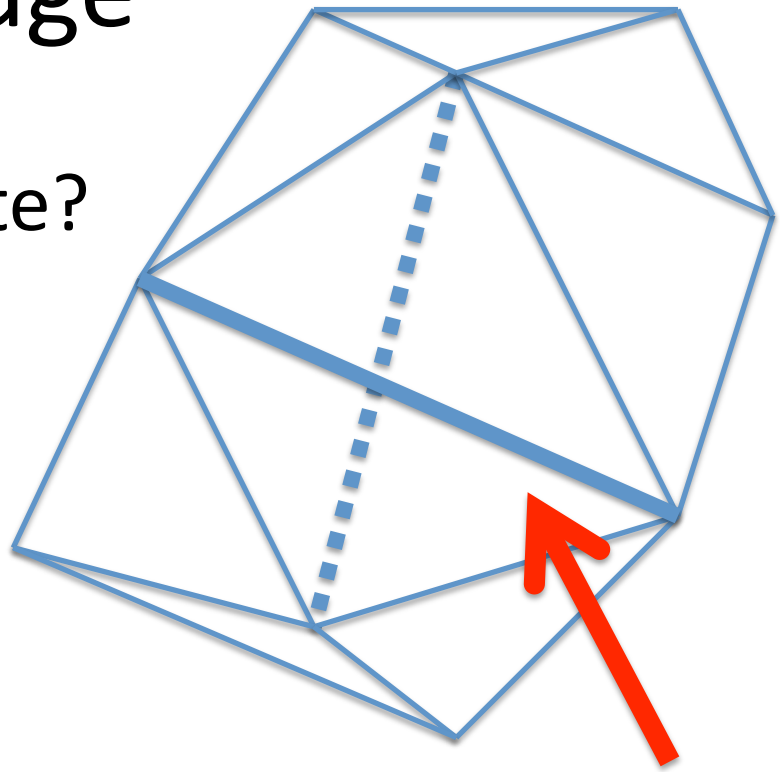
Flip an Edge

- What do we need to update?
  - Half-edges on the edge



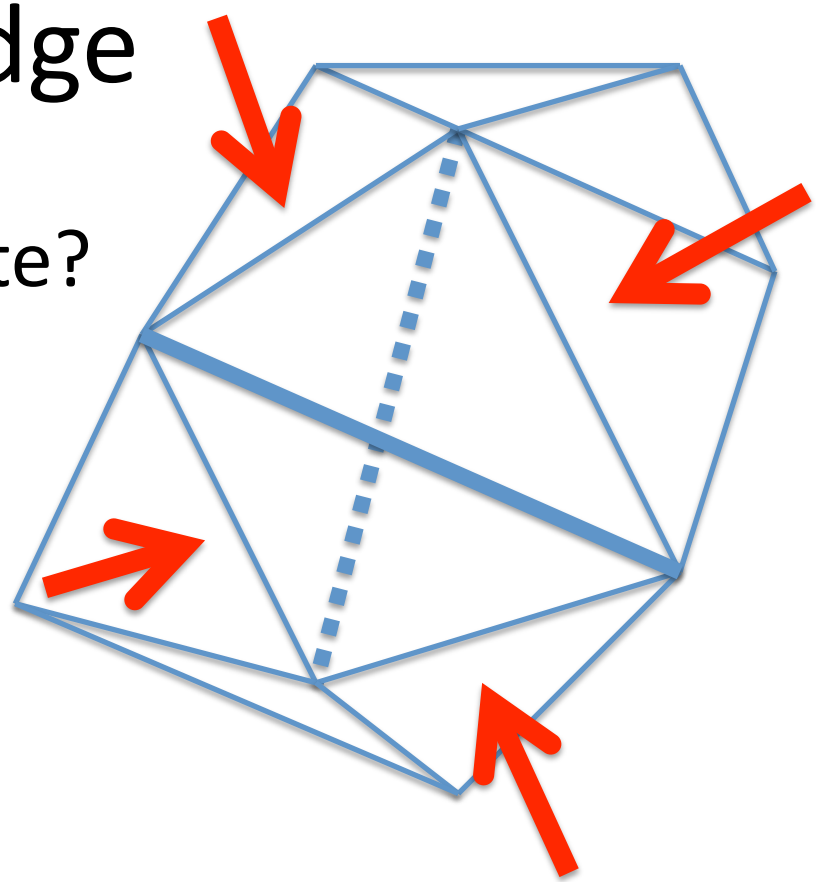
Flip an Edge

- What do we need to update?
  - Half-edges on the edge
    - vertex, next



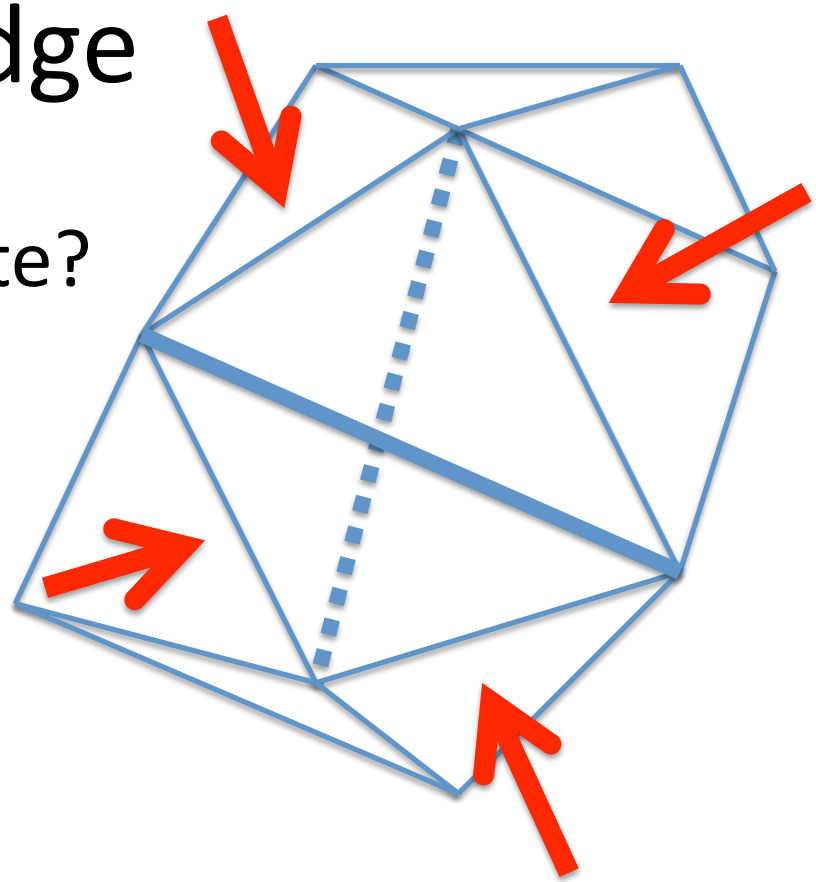
Flip an Edge

- What do we need to update?
  - Half-edges on the edge
    - vertex, next
  - Adjacent half-edges



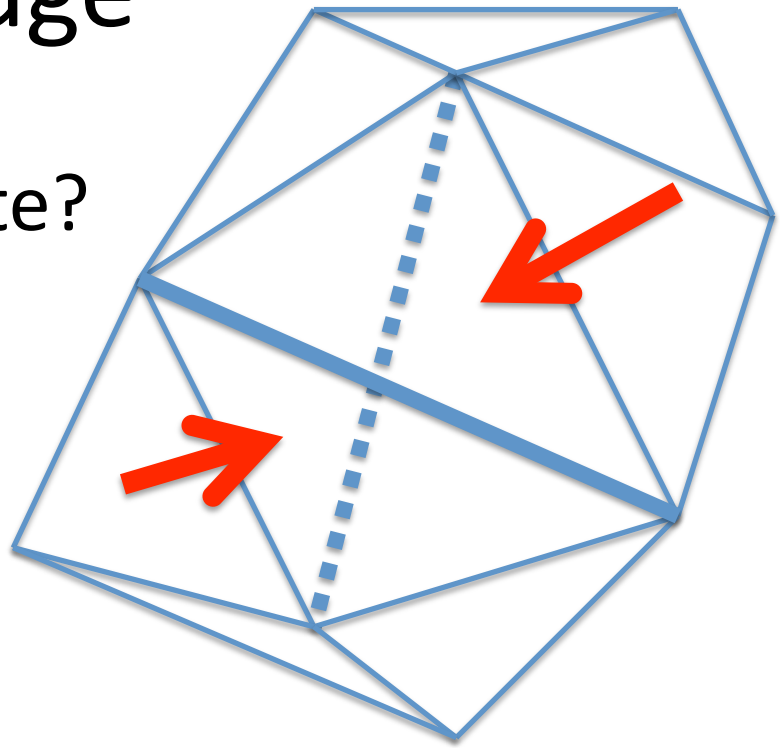
Flip an Edge

- What do we need to update?
  - Half-edges on the edge
    - vertex, next
  - Adjacent half-edges
    - next



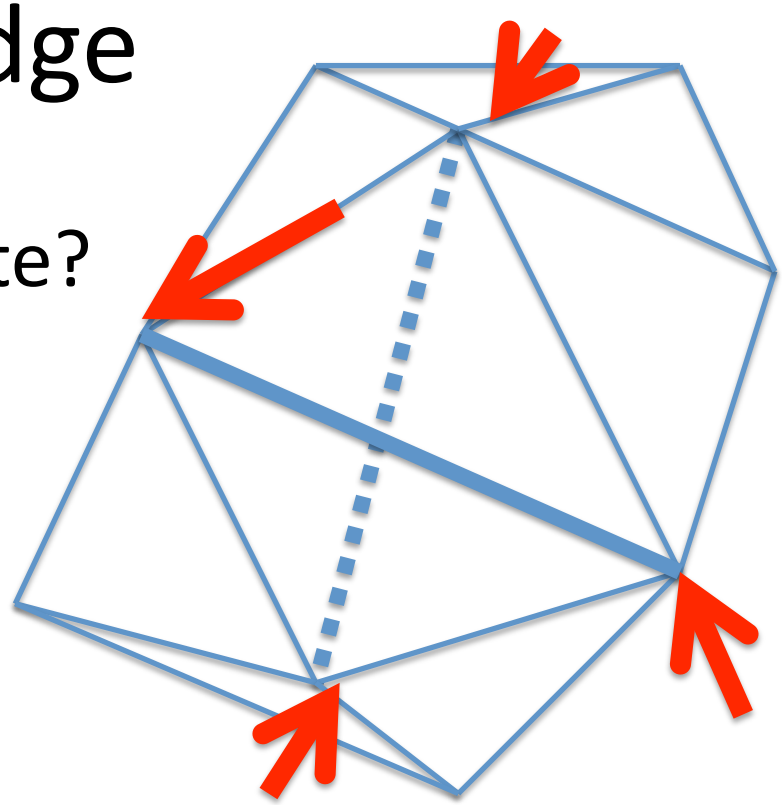
Flip an Edge

- What do we need to update?
  - Half-edges on the edge
    - vertex, next
  - Adjacent half-edges
    - next
  - Faces



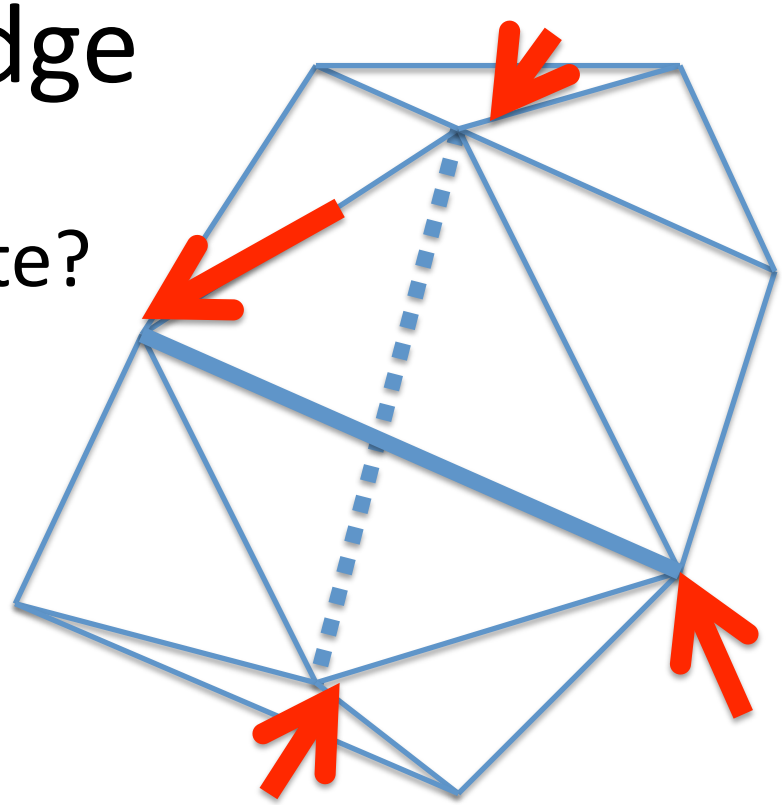
Flip an Edge

- What do we need to update?
  - Half-edges on the edge
    - vertex, next
  - Adjacent half-edges
    - next
  - Faces
  - Vertices

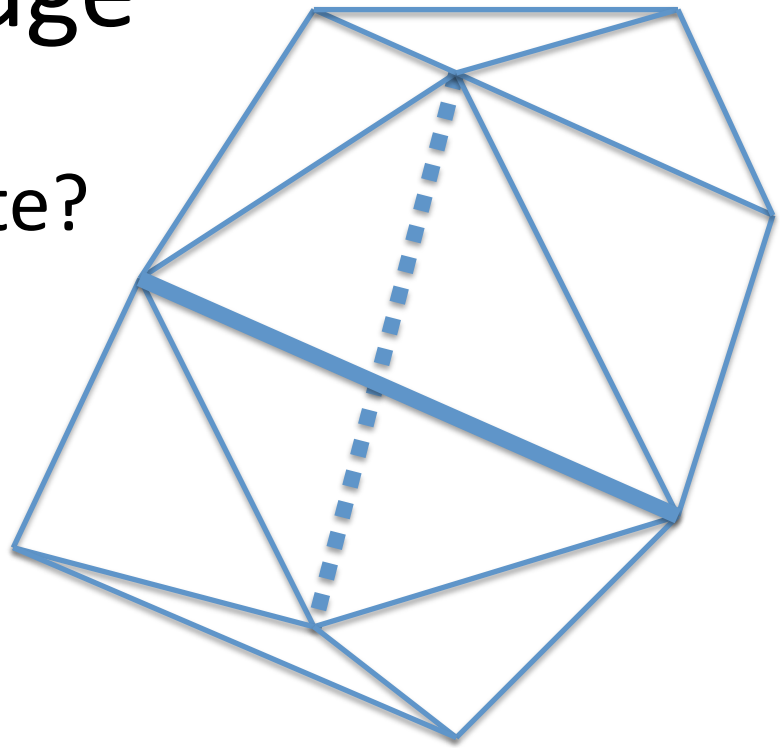


Flip an Edge

- What do we need to update?
  - Half-edges on the edge
    - vertex, next
  - Adjacent half-edges
    - next
  - Faces
  - Vertices
    - possibly ‘outgoing edge’



Flip an Edge



- What do we need to update?
  - Half-edges on the edge
    - vertex, next
  - Adjacent half-edges
    - next
  - Faces
  - Vertices
    - possibly ‘outgoing edge’
  - Problems? Can we always flip edges?