COS 426 : Precept 5
Working with Half-Edge

Agenda

- How to tackle implementation of more advanced features
- Specific discussion
  - Truncate
  - Extrude
  - Triangle Subdivision
  - Bevel(?)
  - Quad Subdivision(?)

How do I start?

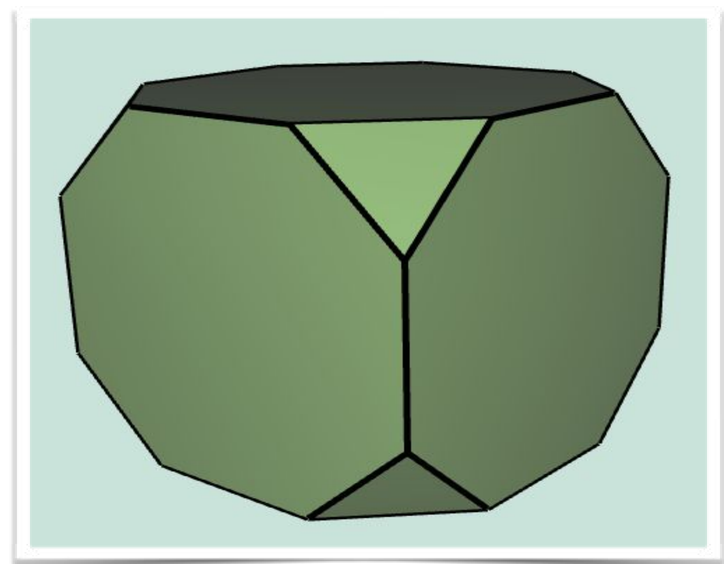
- Some of the operations are tricky to implement!
- Think locally - independence of operations
  - Modifying a vertex/edge/face should not influence other primitives
- Start small
  - Just work on one primitive at a time
- Decouple topology and geometry
  - What are necessary topological changes?
  - What are necessary geometrical changes?
  - Apply geometrical change after topological

Caution is advised

- Need to think ahead
  - What data might change?
  - Do you need to store it beforehand?
- Pen and paper!
  - Draw things out, make sure you understand what is happening
- Count!
  - After applying your operation how many new vertices you expect to see?

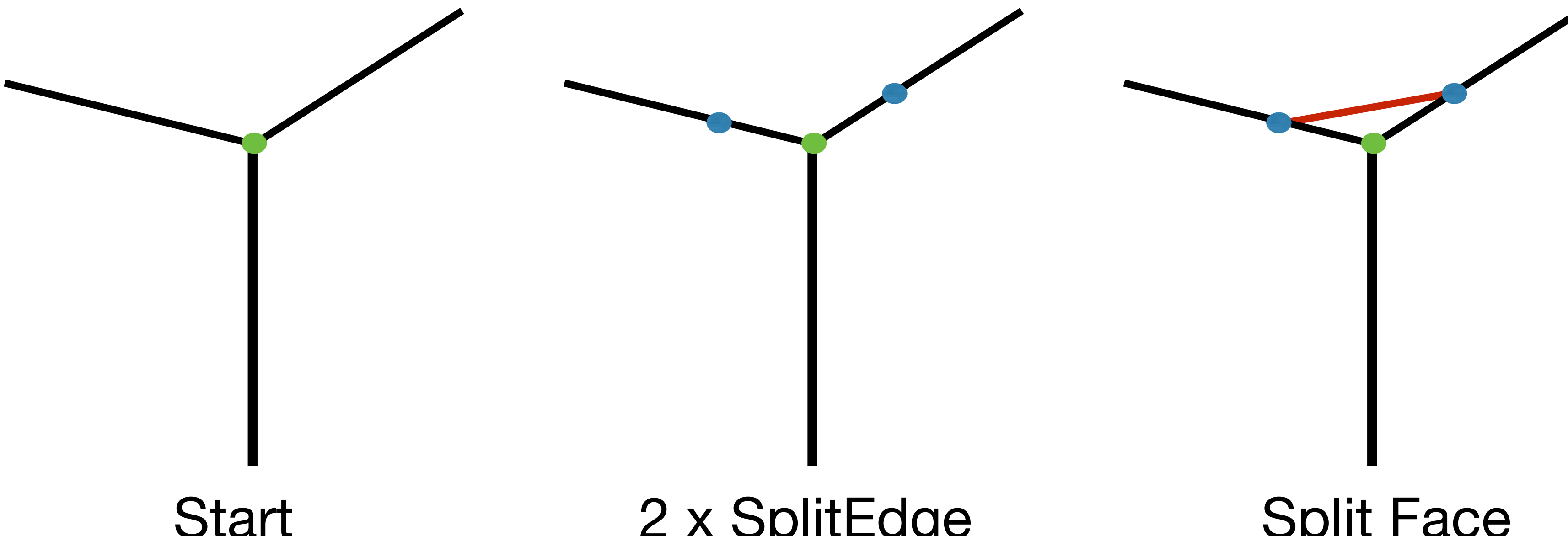
Truncate

- Corners of the shape are cutoff
- Main primitive
  - Vertex
- How many new vertices?
  - +2 per vertex
- How many new faces?
  - +1 per vertex



Truncate - topology

- Start locally - just consider single vertex
- Need to add two new vertices, and a single new face

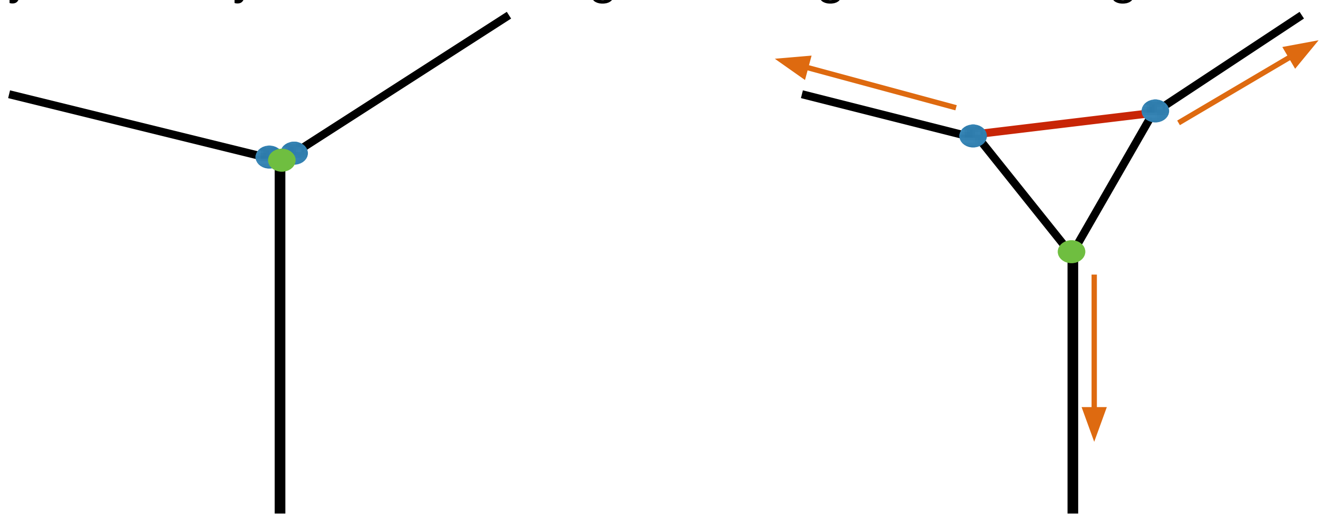


Truncate - topology

- Start locally - just consider single vertex
- Need to add two new vertices, and a single new face

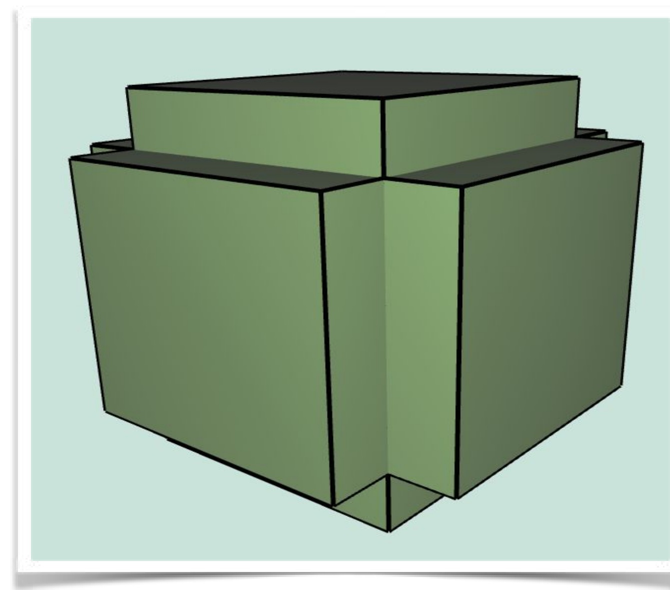
Truncate - geometry

- We need to move vertices along halfedges
  - You may want to store the respective offset vectors per vertex before hand
  - As you modify one vertex lengths of edges will change!



Extrude

- Each face is moved along its normal, with new faces stitched to original face position
- Main primitive
  - Face
- How many new vertices?
  - +n per n-gon
- How many new faces?
  - +n per n-gon



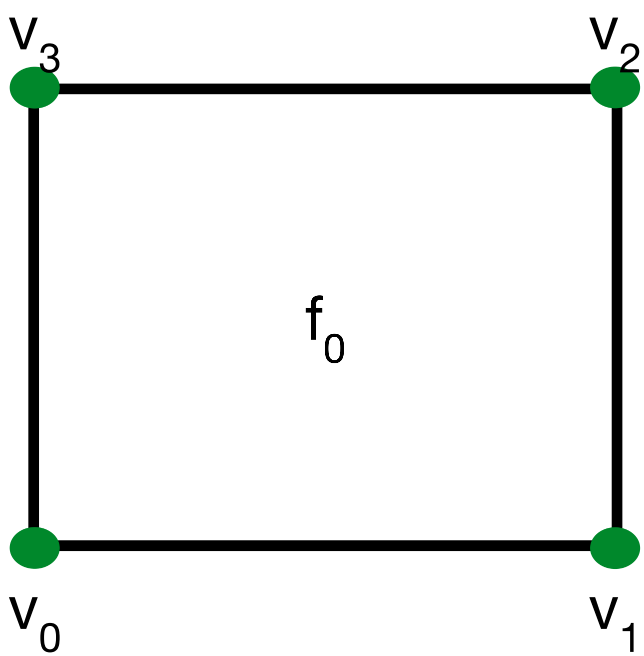
Extrude - topology

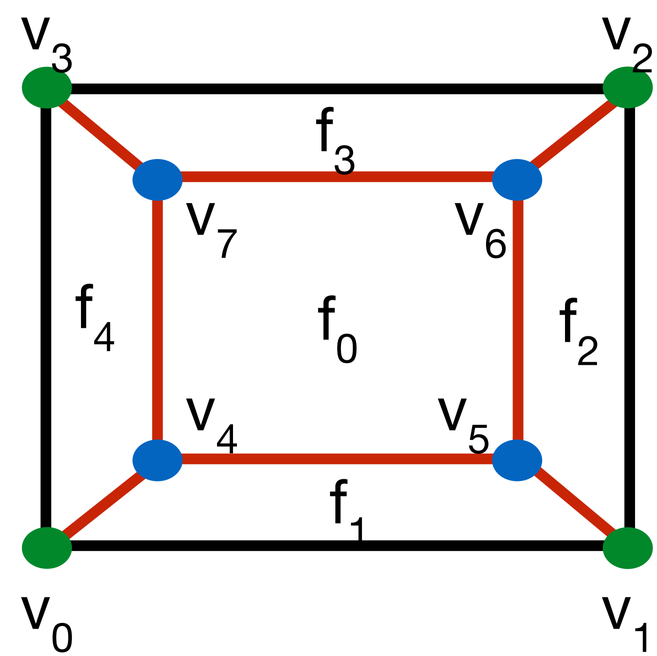
- Again, following figures are for illustration only, new vertices should be added at a location of the old ones!

Extrude - topology

- Extrude is bit harder - you need to perform adding new geometry and relinking manually.

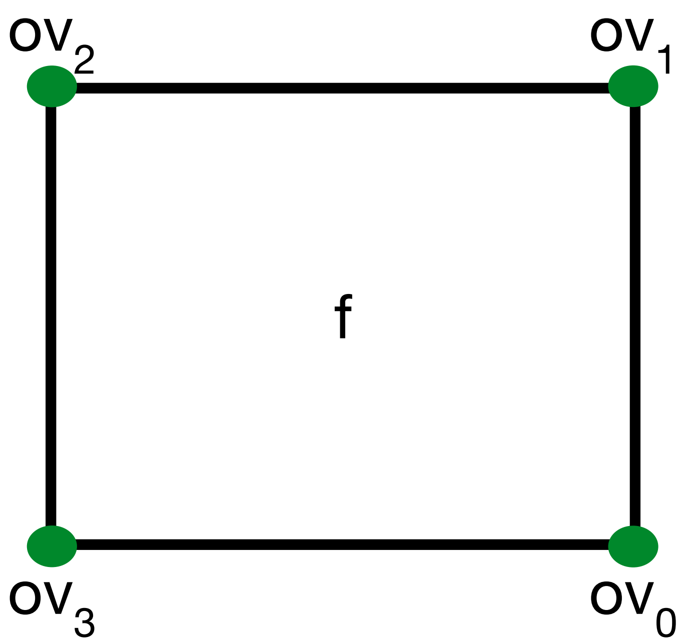
- Desired:





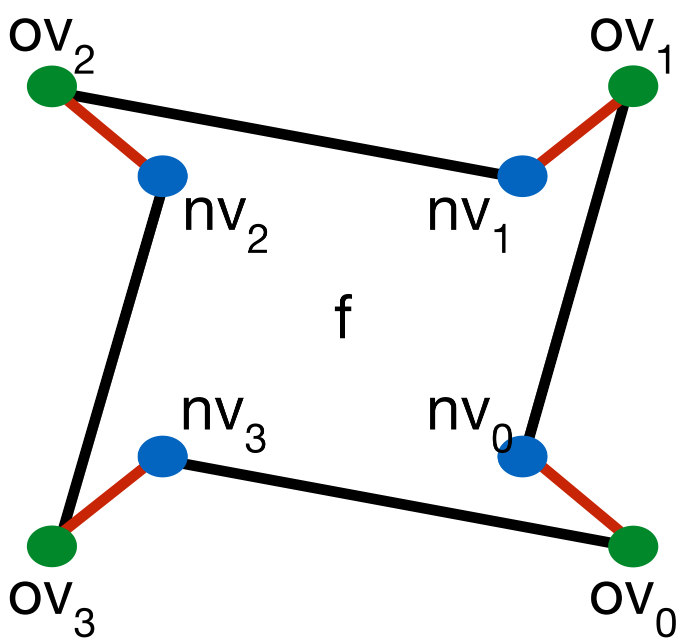
Extrude - topology

- Let's change notation a bit, introduce old and new vertices



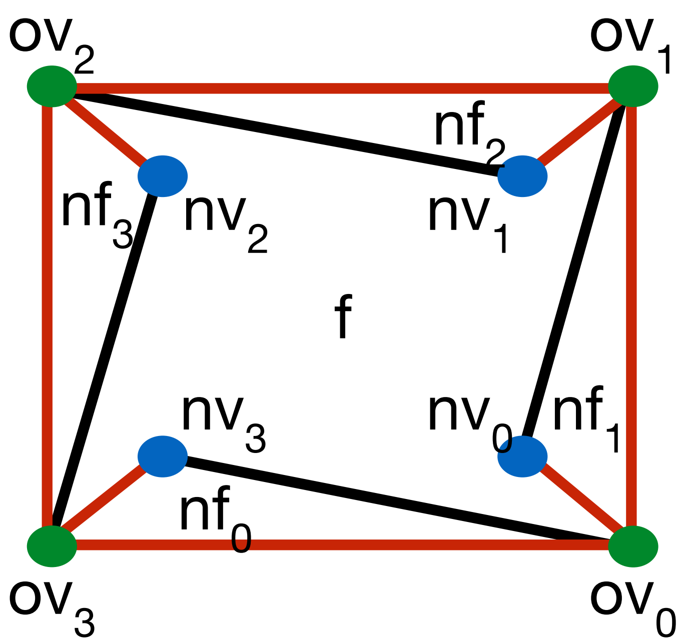
Extrude - topology

- Let's change notation a bit, introduce old and new vertices



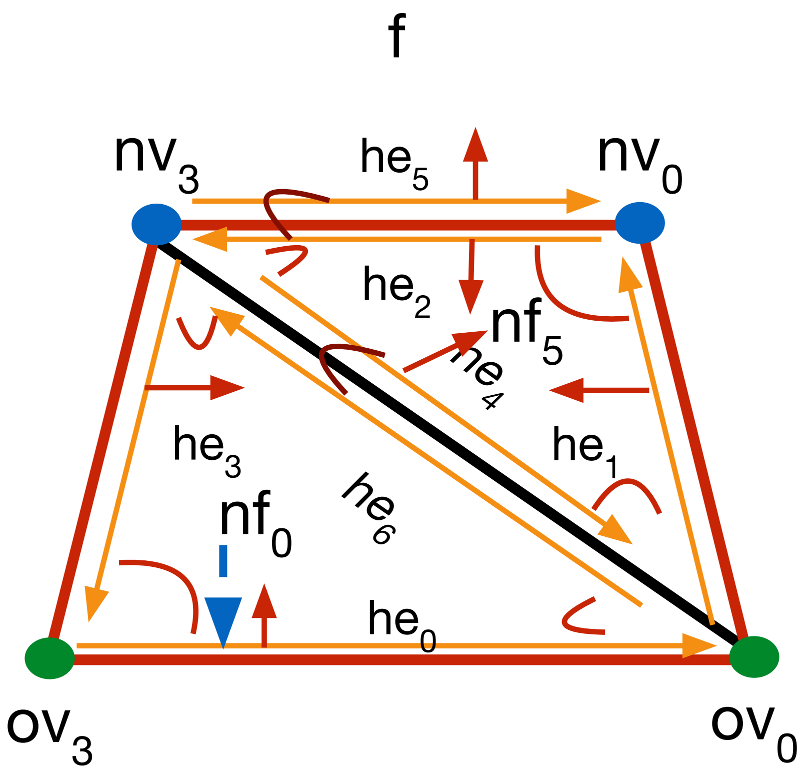
nv_i = splitEdgeMakeVert(
ov_i, ov_{i+1}, 0);

Extrude - topology



nf_i = splitFaceMakeEdge();

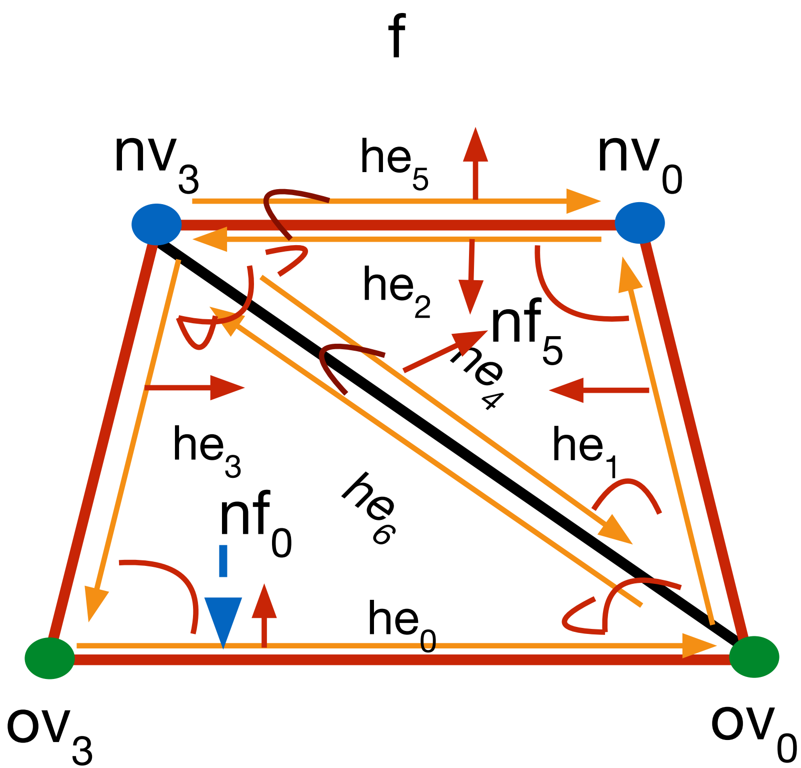
Extrude - topology



Want to connect up the new vertices

nf_5 = splitFaceMakeEdge(
f, nv_0, nv_3);

Extrude - topology



Want to delete old edge

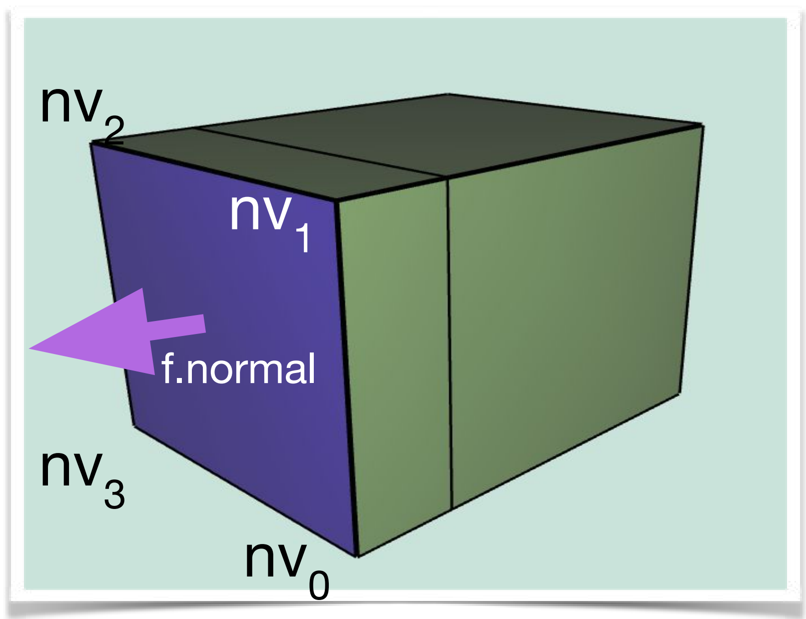
Should be stored before hand

he_4 = old_halfedges[0];

joinFaceKillEdgeSimple(he_6);

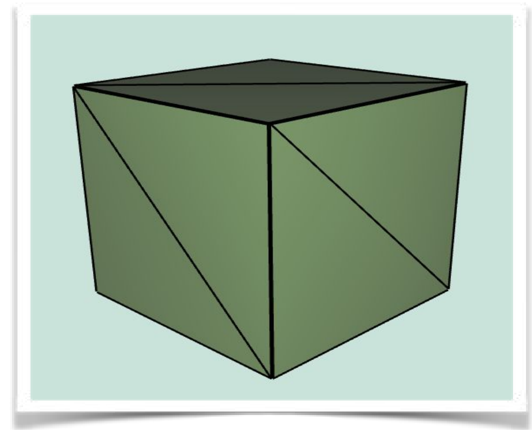
Extrude - geometry

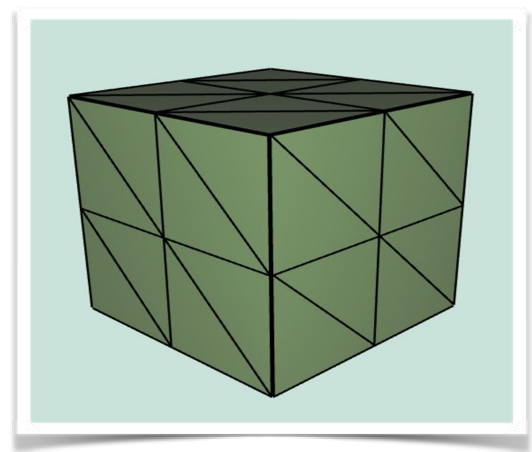
- Actually, very simple
- Move each nv_i by `factor * f.normal`



Triangle Topology

- Each face becomes 4 faces, by splitting all edges in half
- Assumes all triangles!
  - Call your Filters.triangulate();
- Main primitive
  - Face
- How many new vertices?
  - +1 per edge
- How many new faces?
  - +3 per face



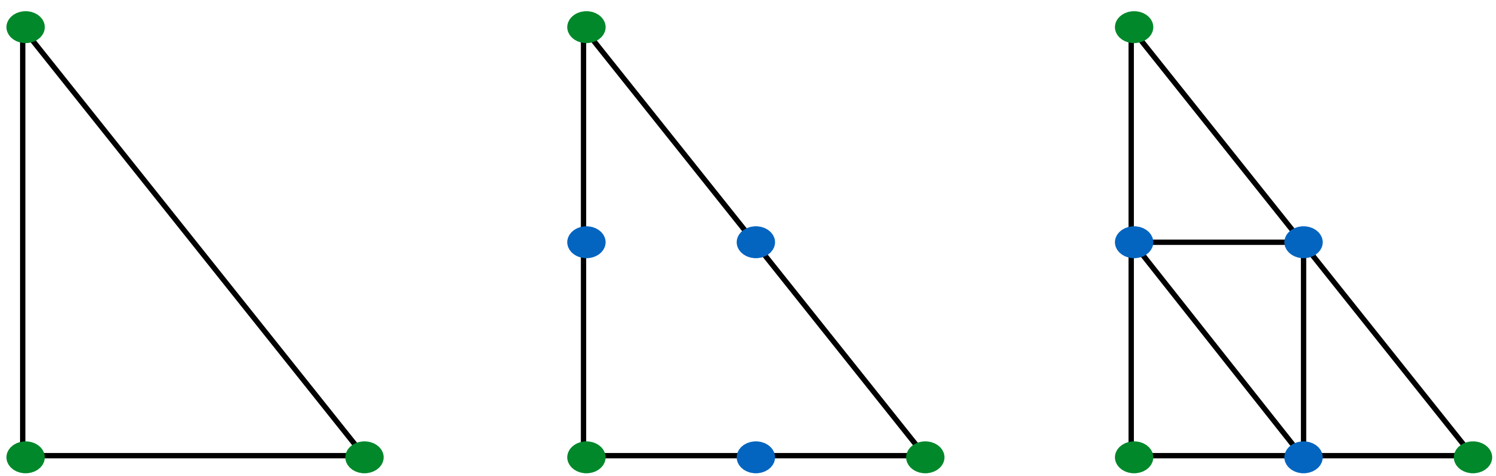


TriTop - topology

- Need to split all edges!
- Create list of half edges
    - Half of them, when splitting halfedge, opposite will also be split
- Join new vertices around a face
    - Determine whether a vertex is old or new by index in vertices array
    - All new will be added to the end of the array!

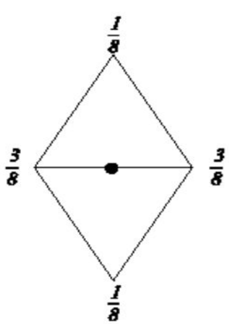
TriTop - topology

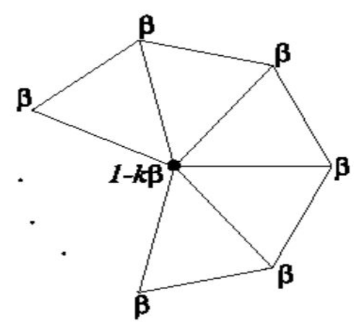
- SplitEdge for each half edge in pre-computed list
- SplitFace per each face, joining new vertices



TriTop - geometry

- None - we’re done!
- For Loop Subdivision - store array of new positions for each vertex, where you will write positions calculated according to weight rules
- After done with topology, update positions!





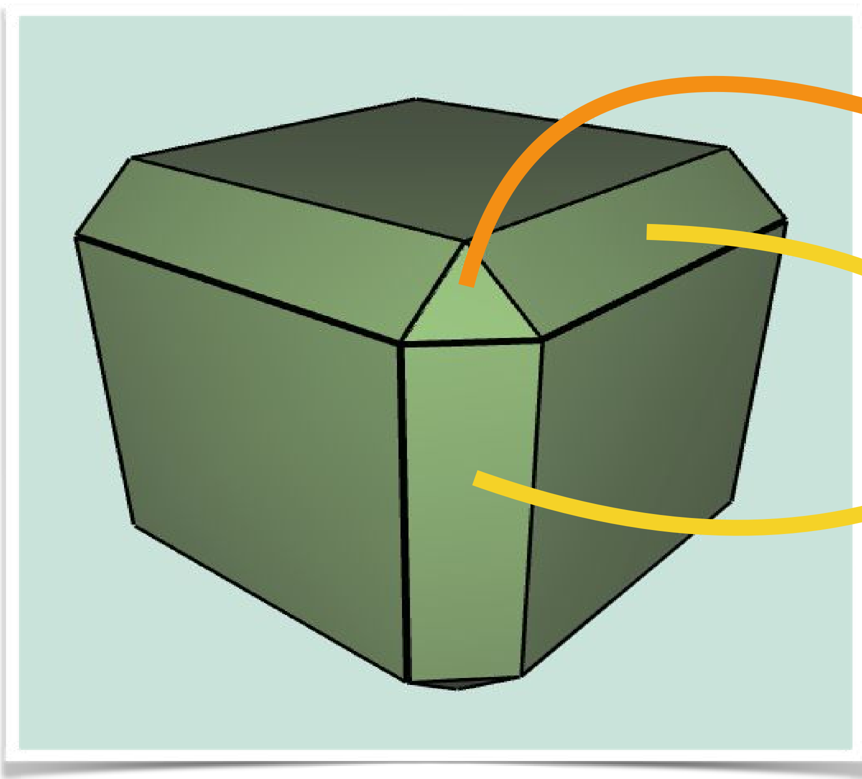
$$\beta = \begin{cases} \frac{3}{8n} & n > 3 \\ \frac{3}{16} & n = 3 \end{cases}$$

Optional features

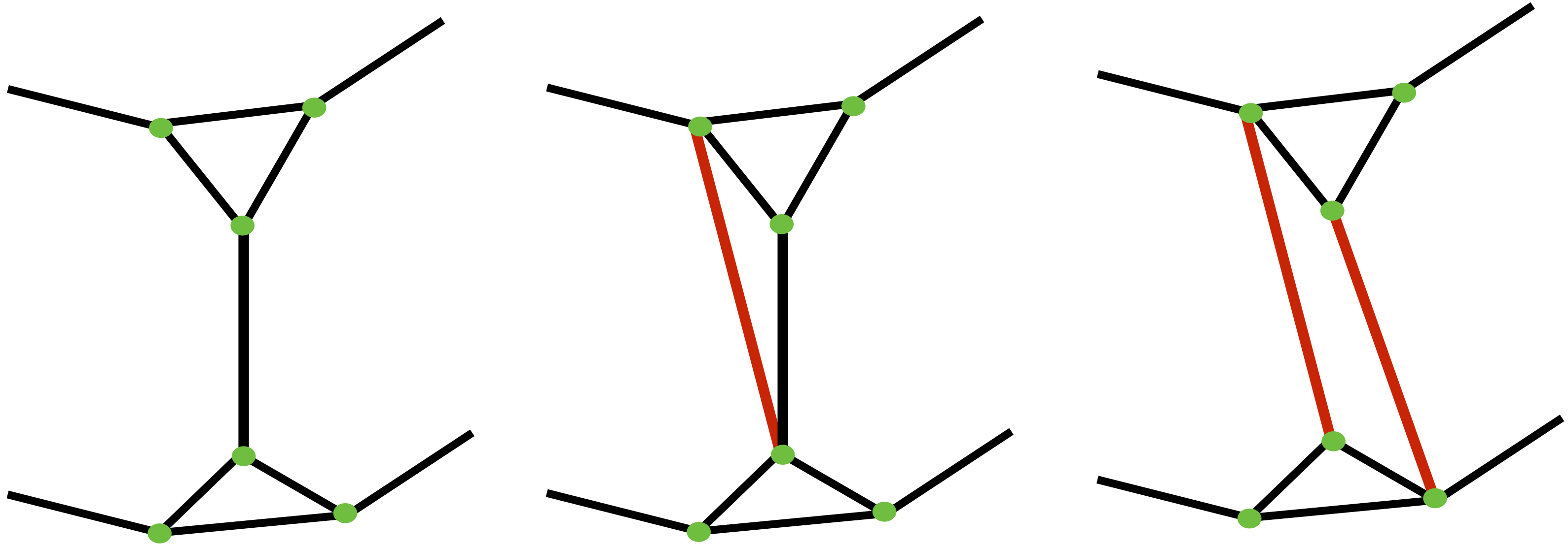
- Bevel
- Quad Subdivision
- We will just gloss over those

Bevel

- Let’s think about required topology.



Bevel topology



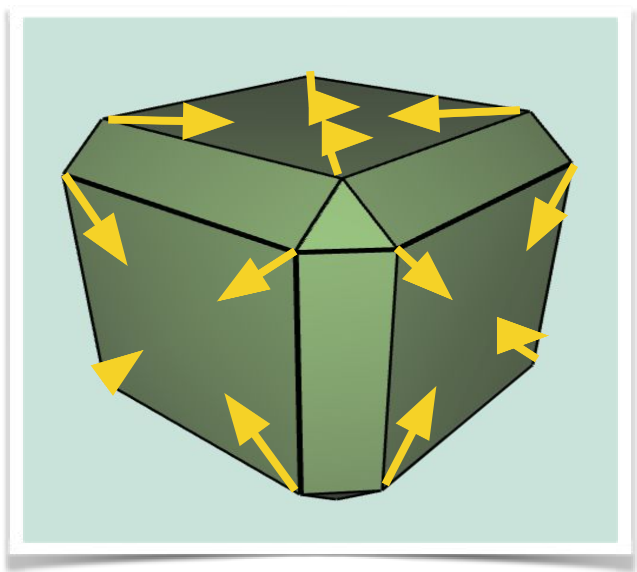
Start with truncate | Cut a triangle | Relink original edge

Bevel - topology

- Select half edges that join truncated points
- Caution when selecting half-edges to perform split
    - Make sure you’re not double counting
- Moving an edge requires manual relinking

Bevel - geometry

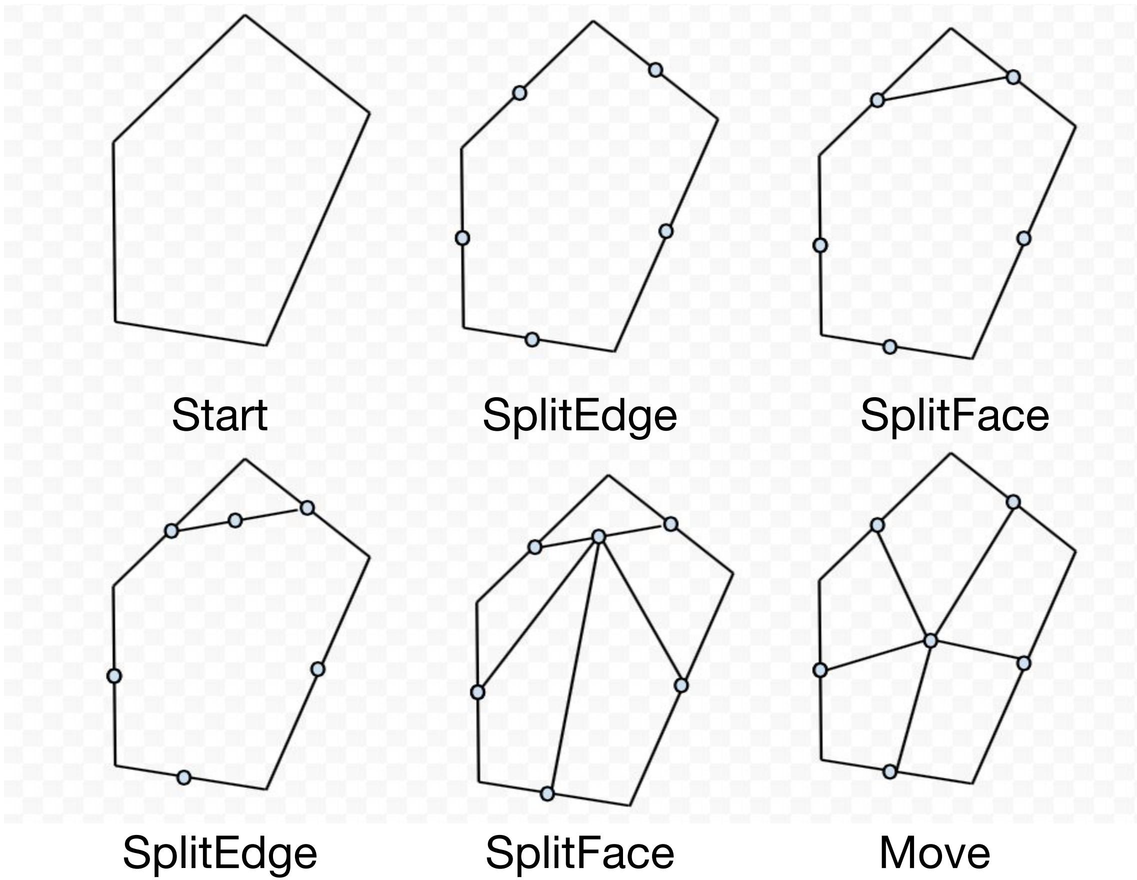
- All new vertices are at location of the respective original vertex
- Can move them towards the centroid of the main face



Quad Topology

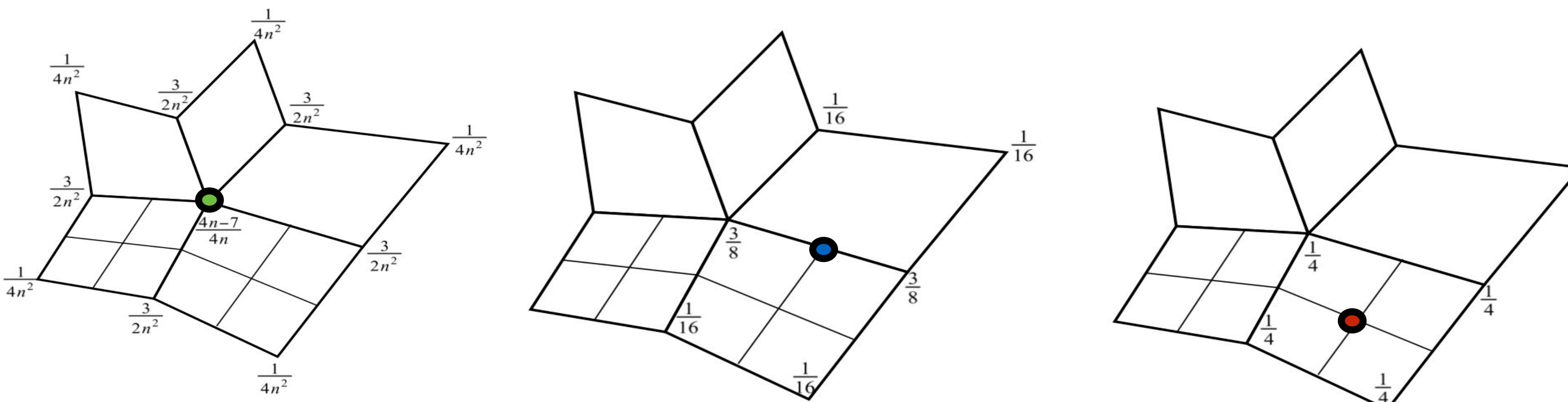
- n-gon to quad split
  - Split each edge (SplitEdge)
  - Join 2 new vertices (SplitFace)
  - Split newly create edge (SplitEdge)
  - Join rest of new vertices (SplitFace)
  - Move to interior vertex to centroid location

Quad Topology



Quad Subdivision

- Three classes
  - Old vertices
  - Midpoints
  - Centroids



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