Loop Subdivision Scheme
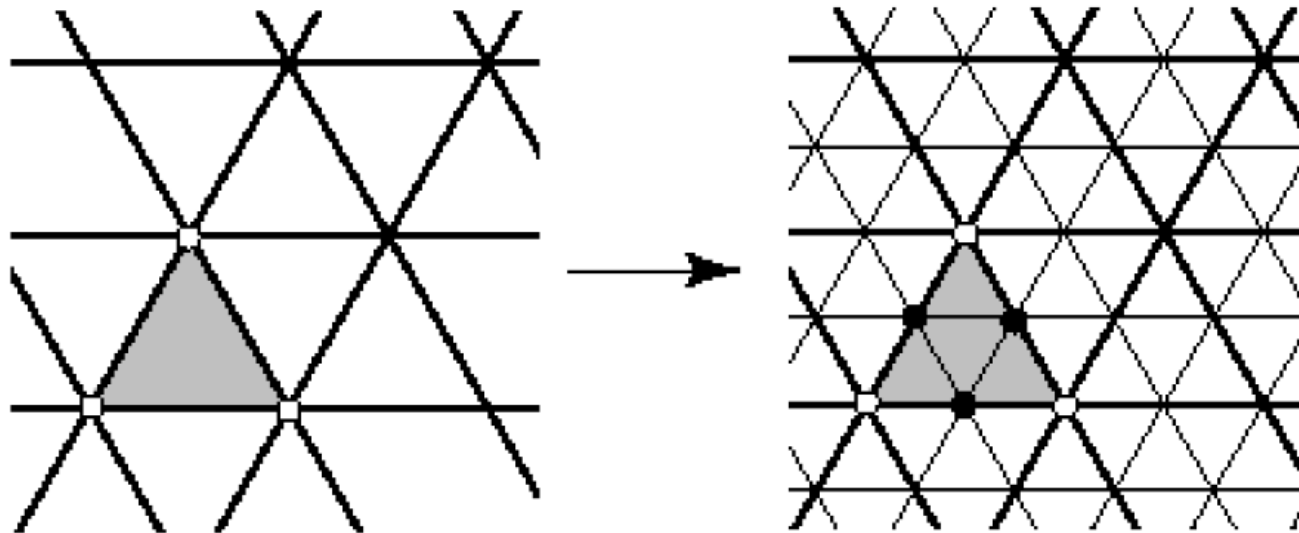
- How to subdivide the mesh?

  Refinement:

  » Subdivide each triangle into 4 triangles by splitting each edge and connecting new vertices
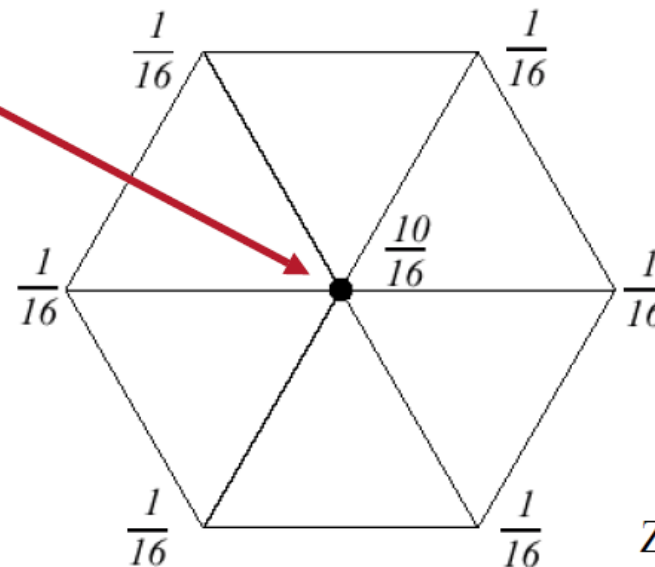
Loop Subdivision Scheme

- How to subdivide the mesh:

  Refinement

  Smoothing:

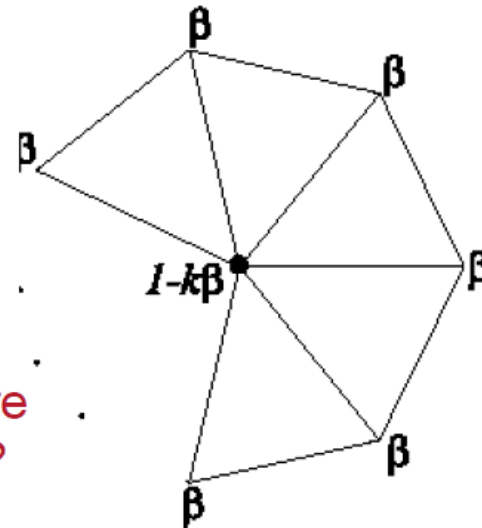 » <u>Existing Vertices</u>: Choose *new* location as weighted average of *original* vertex and its neighbors

Existing vertex being moved from one level to the next

$$\frac{1}{16} \qquad \frac{1}{16}$$

$$\frac{1}{16} \qquad \frac{10}{16} \qquad \frac{1}{16}$$

$$\frac{1}{16} \qquad \frac{1}{16}$$

Zorin & Schroeder
SIGGRAPH 99
Course Notes

Loop Subdivision Scheme

- General rule for moving existing *interior vertices*:
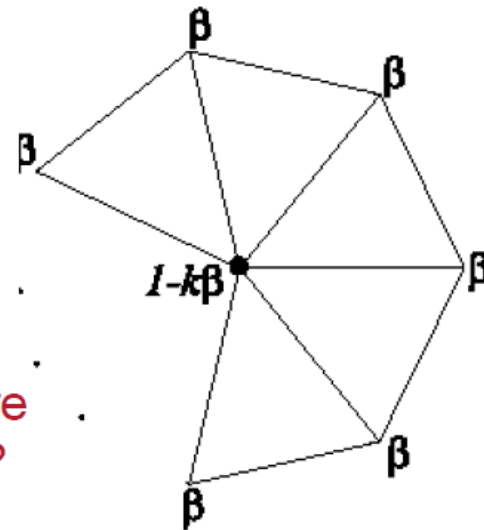

What about vertices that have more
Or less than 6 neighboring faces?

New_position = (1 - $k\beta$)original_position + sum(β * *each_original_vertex*)

Loop Subdivision Scheme

- General rule for moving existing *interior vertices*:

What about vertices that have more
Or less than 6 neighboring faces?

New ... tex)

$0 \leq \beta \leq 1/k$:

- As β increases, the contribution from adjacent vertices plays a more important role.

Where do existing vertices move?

- How to choose β?
    - Analyze properties of limit surface
    - Interested in continuity of surface and smoothness
    - Involves calculating eigenvalues of matrices

        » Original Loop

        $$\beta = \tfrac{1}{k}\left(\tfrac{5}{8} - \left(\tfrac{3}{8} + \tfrac{1}{4}\cos\tfrac{2\pi}{k}\right)^2\right)$$

        » Warren

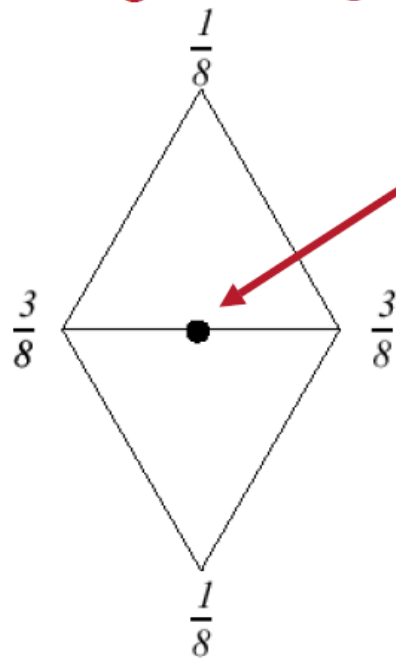 $$\beta = \begin{cases} \tfrac{3}{8k} & n > 3 \\ \tfrac{3}{16} & n = 3 \end{cases}$$

Loop Subdivision Scheme

- How to subdivide the mesh:
  Refinement
  Smoothing:
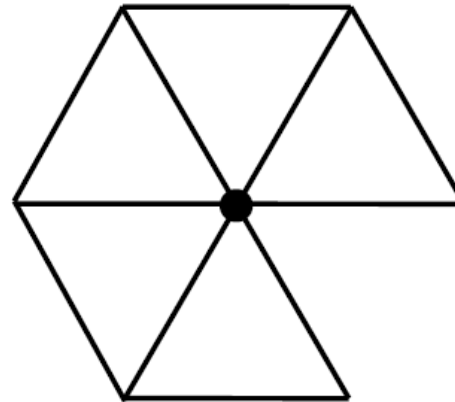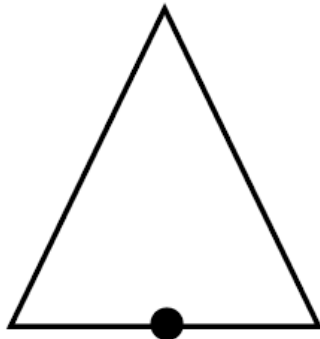   » Inserted Vertices: Choose location as weighted average of *original* vertices in local neighborhood

$$\frac{1}{8}$$

New vertex being inserted

$$\frac{3}{8} \qquad \frac{3}{8}$$
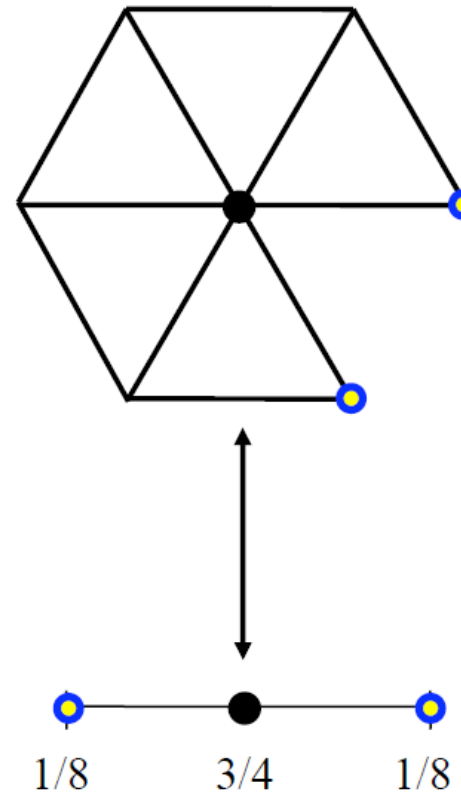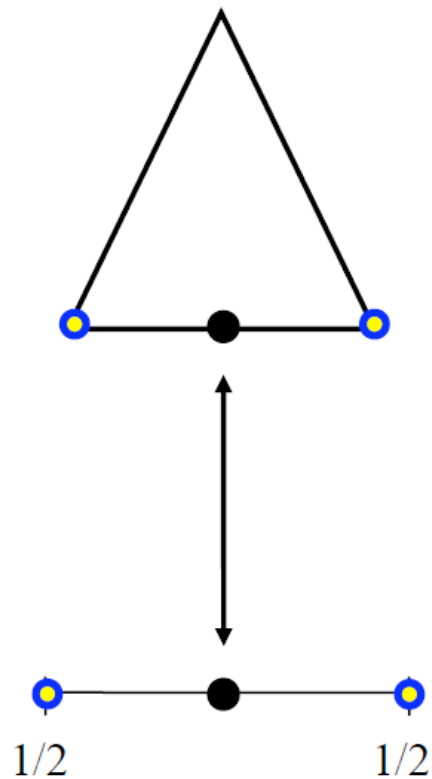
$$\frac{1}{8}$$

Boundary Cases?

- What about *extraordinary vertices* and *boundary edges?*:
  - Existing vertex adjacent to a missing triangle
  - New vertex bordered by only one triangle

Boundary Cases?

- Rules for *extraordinary vertices* and *boundaries*:

1/2   1/2

1/8   3/4   1/8