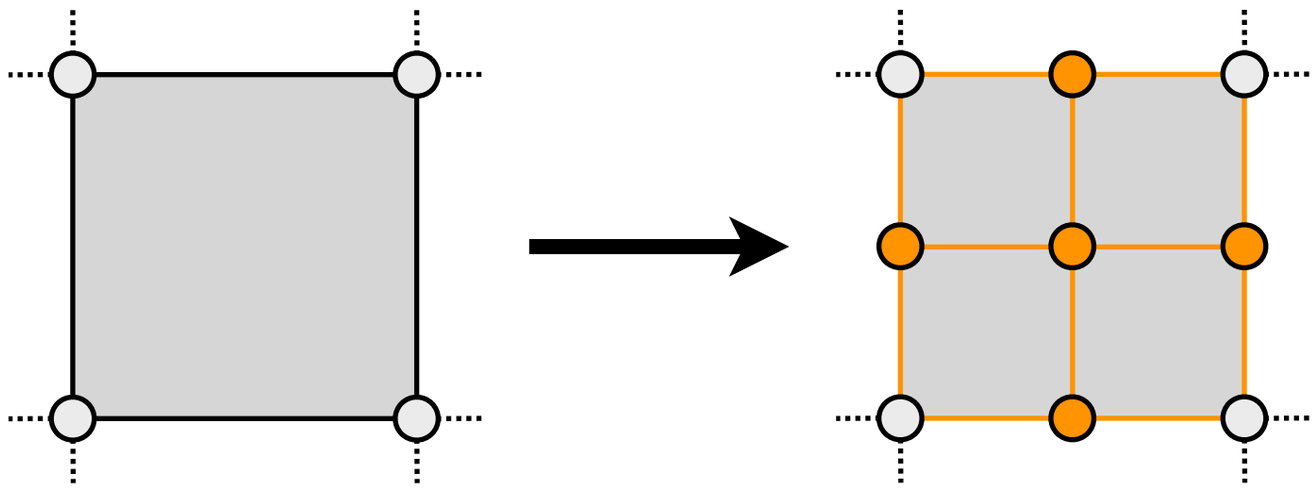
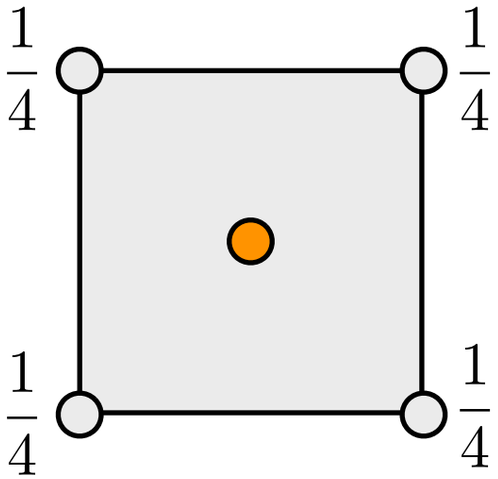
Catmull-Clark Subdivision

- Generalization of bi-cubic B-Splines
- Generates C^2 continuous limit surfaces:
  - C^1 for extraordinary points (valence ≠ 4)
  - C^2 continuous everywhere else

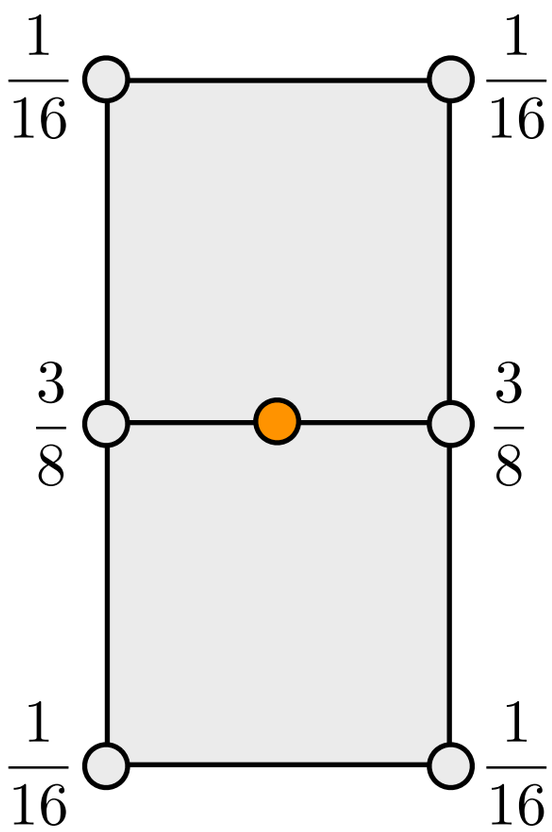


Catmull-Clark Subdivision

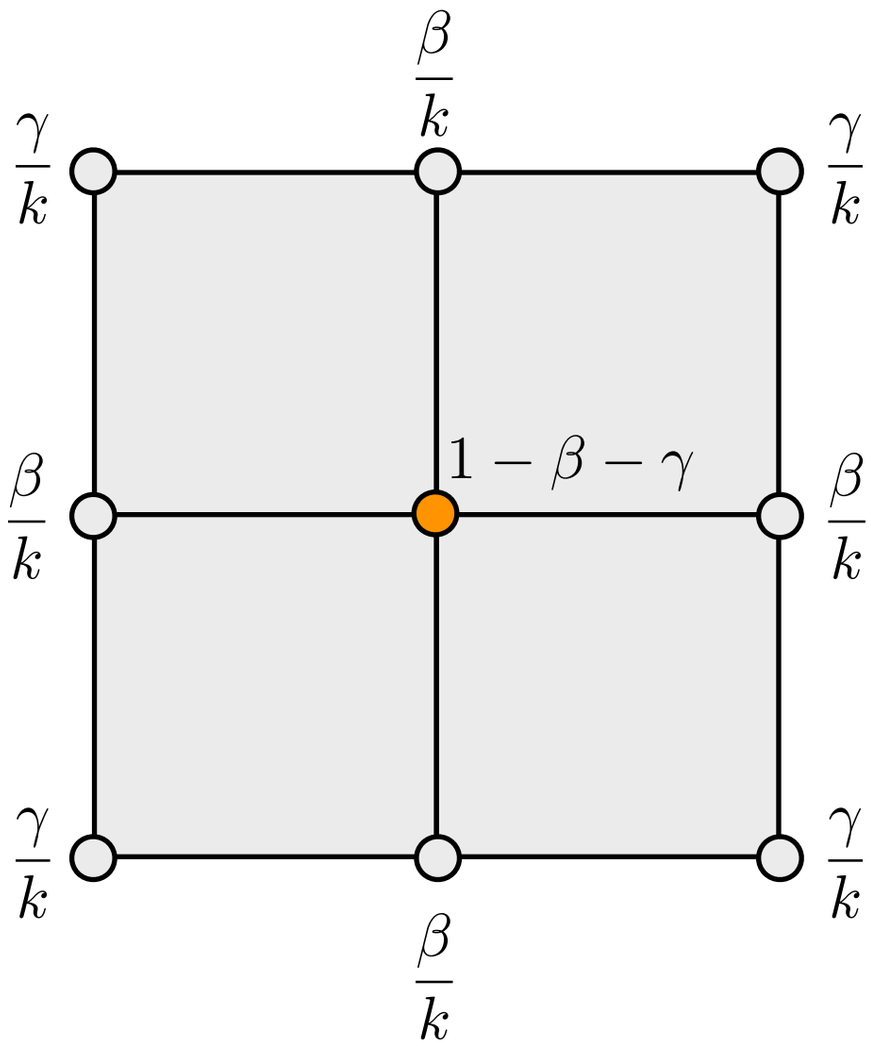
New face vertices



New edge vertices



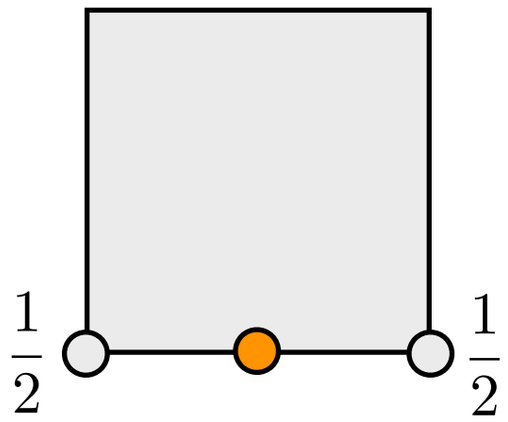
New position for old vertices
(valence k)



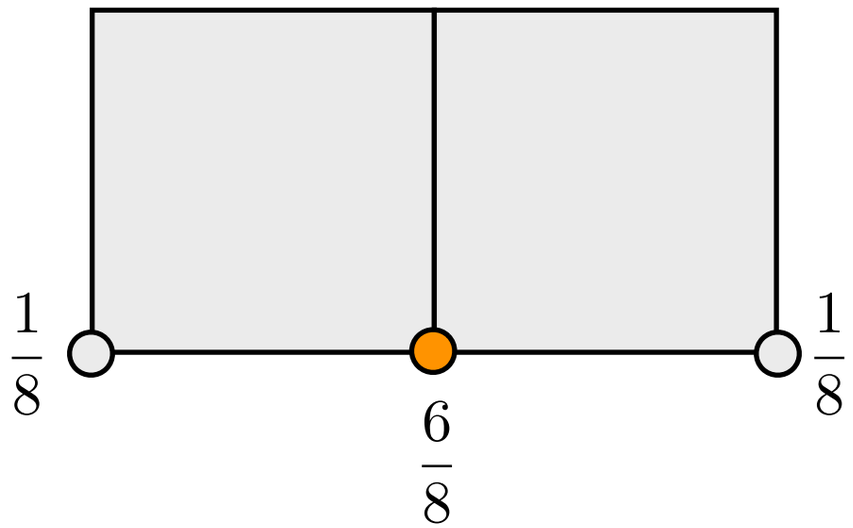
$$\beta = \frac{3}{2k}, \quad \gamma = \frac{1}{4k}$$

Catmull-Clark: Boundary Rules

New boundary edge vertices

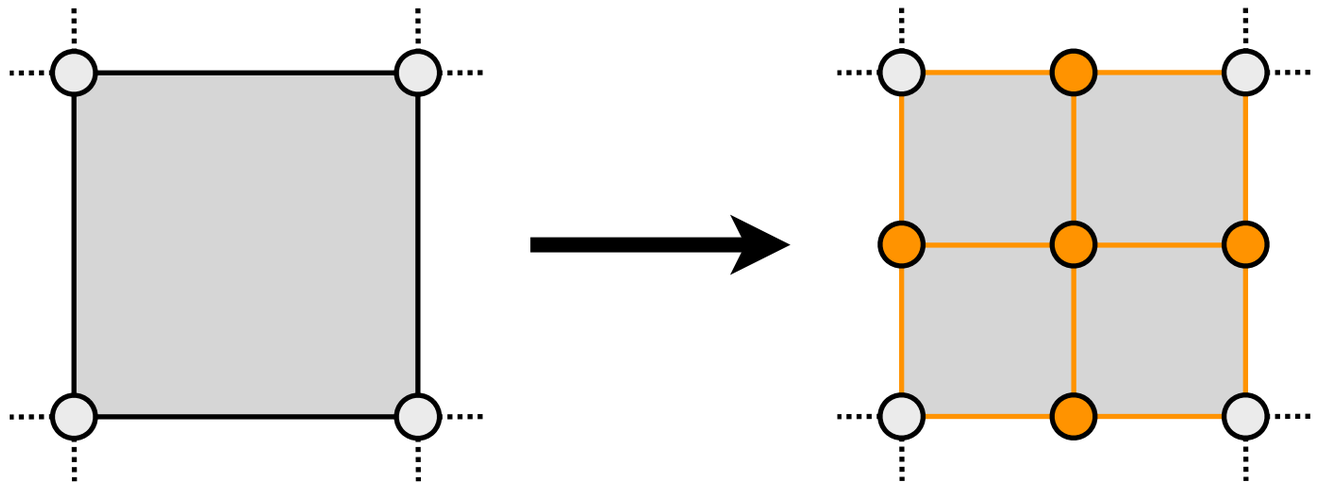


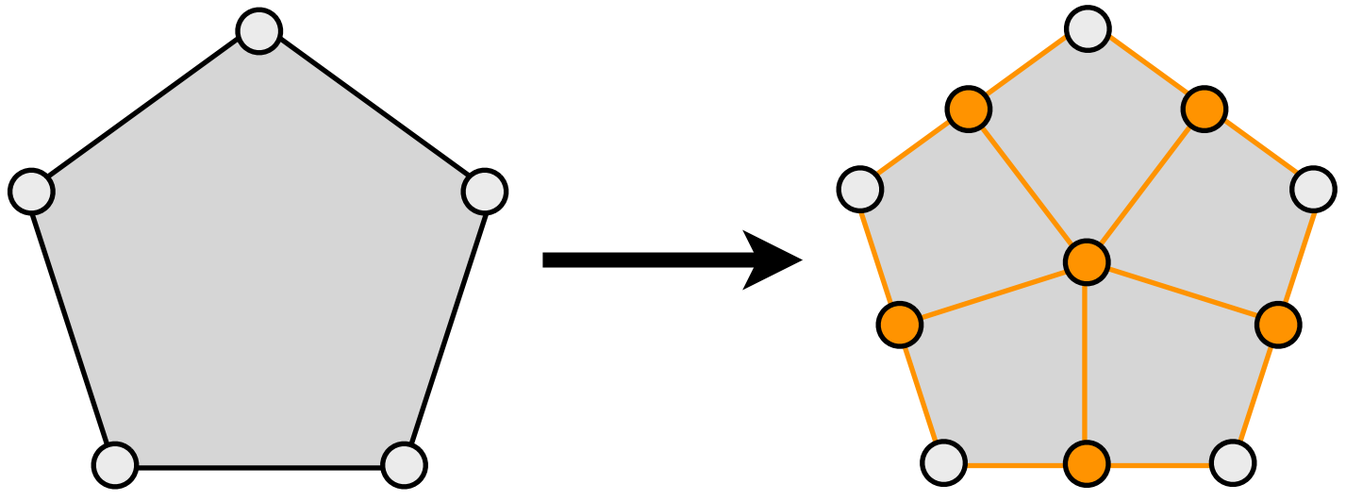
New position for old boundary vertices



Note: Special rules for boundary edges and vertices!

Generalized Catmull-Clark

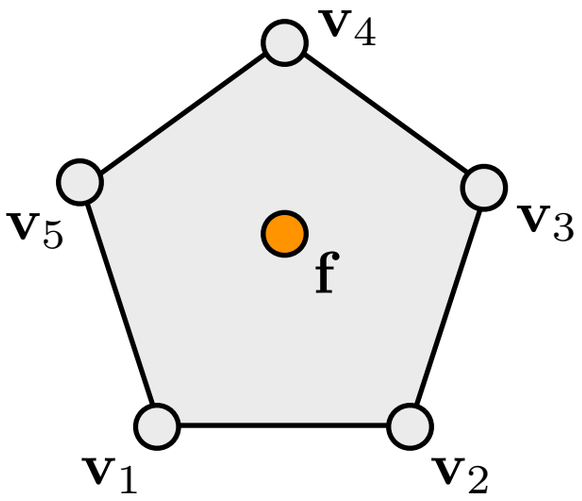




Connect face point to edge-vertex-edge triple
(turns all faces into quads)

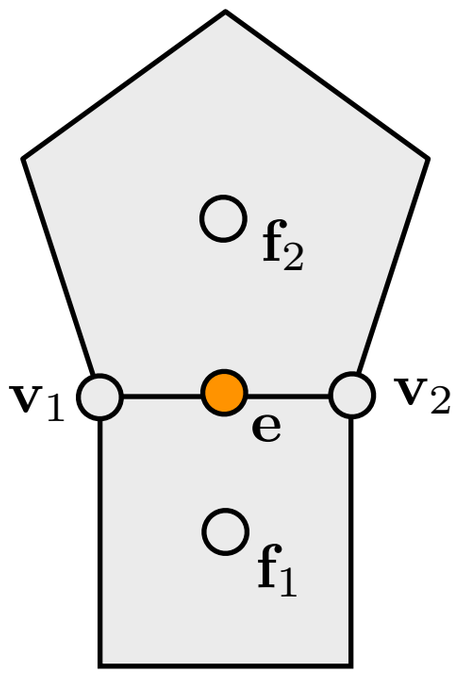
Generalized Catmull-Clark

New face vertices as centroid of n-gon



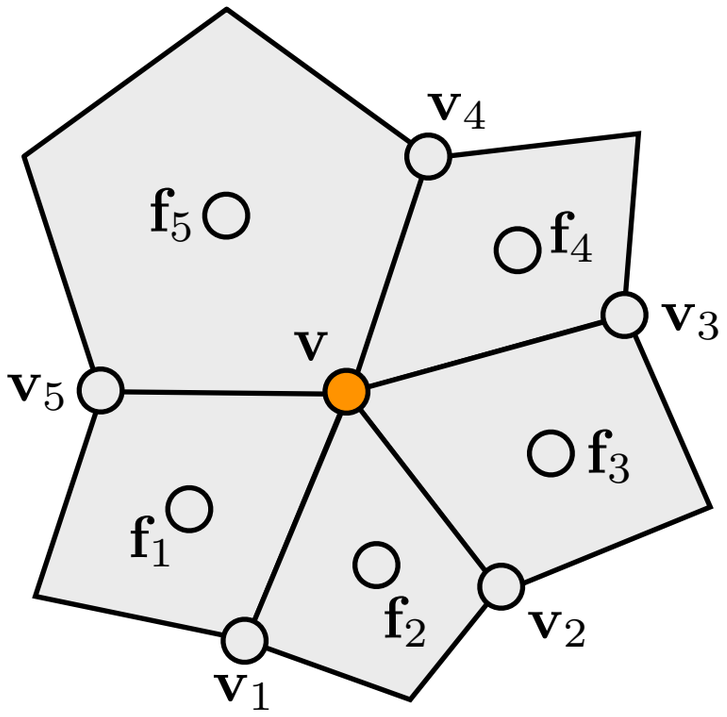
$$\mathbf{f} = \frac{1}{n}\sum_{i=1}^{n}\mathbf{v}_i$$

New edge vertices



$$\mathbf{e} = \frac{1}{4}\left(\mathbf{v}_1 + \mathbf{v}_2 + \mathbf{f}_1 + \mathbf{f}_2\right)$$

New position for old vertices
(valence k)



$$\mathbf{v} = \frac{k-2}{k}\mathbf{v} + \frac{1}{k^2}\sum_{i=1}^{k}\mathbf{v}_i + \frac{1}{k^2}\sum_{i=1}^{k}\mathbf{f}_i$$

Catmull-Clark Subdivision