Catmull–Clark subdivision:

Rewrite 6-sphere subdivision.

Now subdivide along $i$ 

\[ \frac{1}{2}(P_{ij} + P_{ijn}) \]

\[ \frac{1}{4} P_{ij} + \frac{3}{4} P_{ijn} + \frac{1}{8} P_{ijn+1} \]

new points marked as $X$
Catmull - Clark

to subdivide an interval into more col a, col b

\[ x = \frac{1}{2} (P_{ij} + P_{ij+1}) \]

\[ F = \frac{1}{4} \left[ P_{ij} + P_{ij+1} + P_{i+1j} + P_{i+1,j+1} \right] \]

\[ E = \frac{1}{8} \left[ \frac{1}{2} (P_{ij} + P_{ij+1}) \right] + \frac{3}{4} \left[ \frac{1}{2} (P_{i+1j} + P_{i+1,j+1}) \right] + \frac{1}{8} \left[ \frac{1}{2} (P_{i+2j} + P_{i+2,j+1}) \right] \]

Easier form follows.
Now col 6:

\[
\text{we care about this one}
\]

\[
\text{pt is: } \frac{1}{8} m + \frac{3}{4} n + \frac{1}{8} q
\]

\[
= \frac{1}{8} \left[ \frac{1}{8} P_{ij-1} + \frac{3}{4} P_{ij} + \frac{1}{8} P_{ij+1} \right]
\]

\[
+ \frac{3}{4} \left[ \frac{1}{8} P_{i+1j-1} + \frac{3}{4} P_{i+1j} + \frac{1}{8} P_{i+1j+1} \right]
\]

\[
+ \frac{1}{8} \left[ \frac{1}{8} P_{i+2j-1} + \frac{3}{4} P_{i+2j} + \frac{1}{8} P_{i+2j+1} \right] = p
\]
Catmull - Clark:

- Take each face, construct \( F_{ij} = \) [are verts of face]

- Now take each edge, construct

\[
E = \frac{1}{4} \left[ \text{are the incident} \left( \text{Sum of incident face points} + \text{Sum of incident points} \right) \right]
\]
Now we have just 1 and the rest.

Ave incident face points

Ave incident edge points

original value

(please check against formula)
Catmull-Clark:

- Join up to make natural mesh
- Doesn't have to be grid

- What about extraordinary verts?
  (where there are more/less than 3 incident faces)

Idea:

\[ P = \frac{1}{n} \left[ \text{Ave incident face points} + \frac{2}{n} \left[ \text{Ave incident edge points} + (n-3) \times \text{old value} \right] \right] \]

(Catmull-Clark)
(other schemes exist)

Crucial point:

- Make, edit coarse mesh
- "looks like" result
- Subdiv gives smooth surf.