Introduction to Polygonal Meshes

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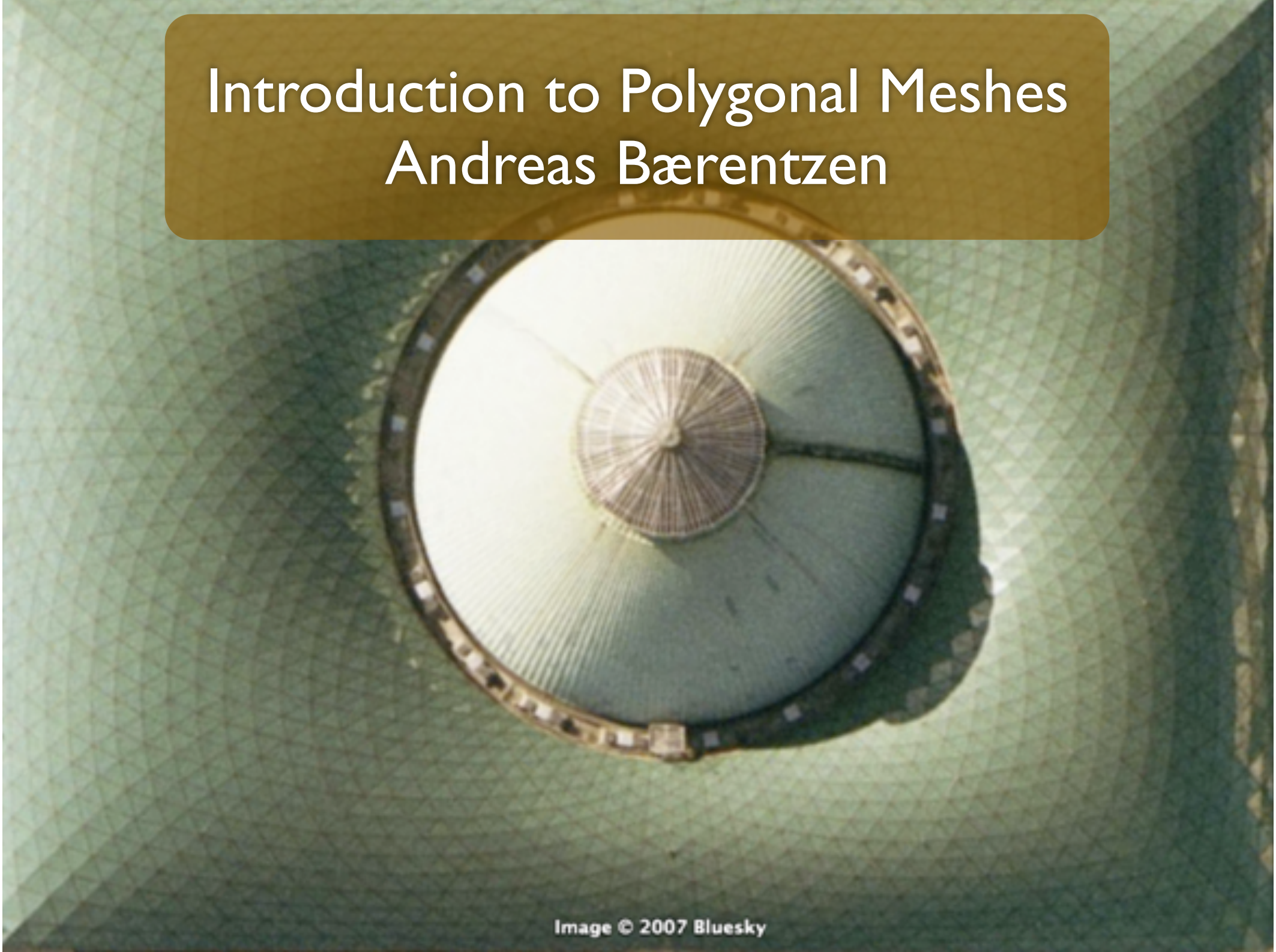
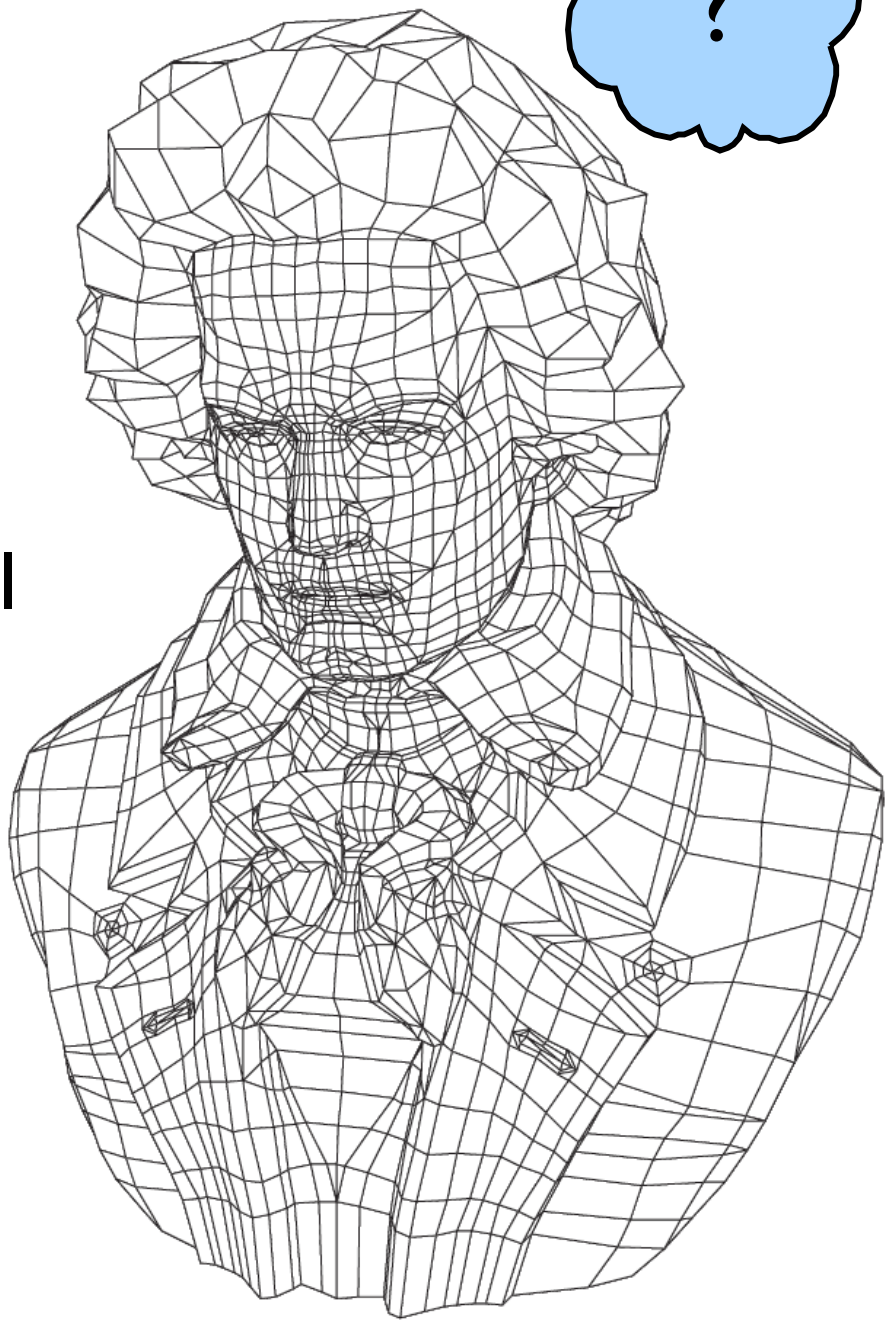
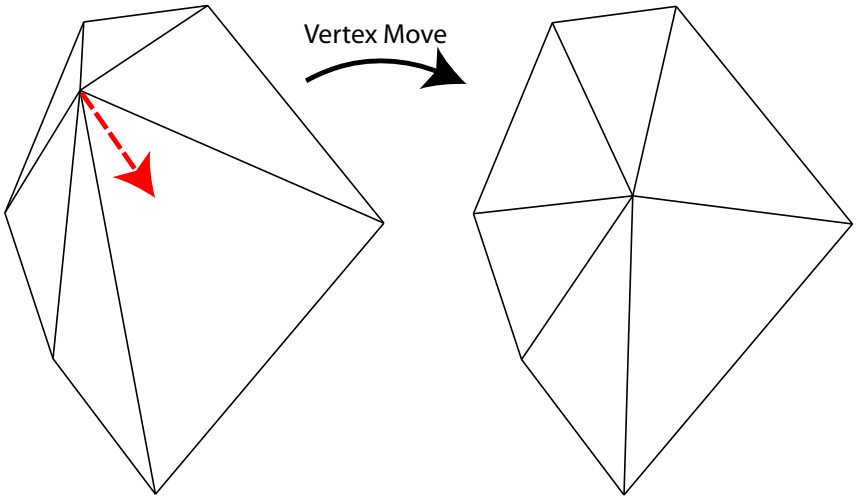


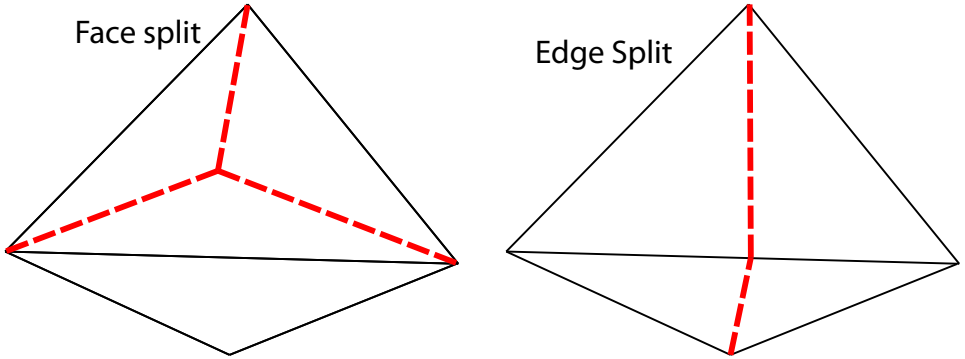
Why Polygonal Meshes?

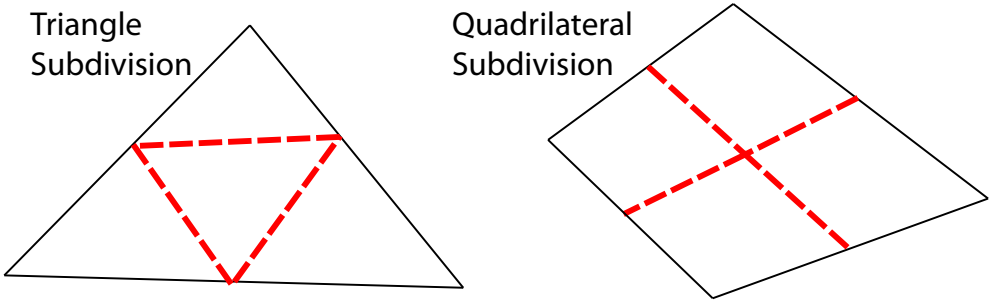
- Polygons are an obvious way of connecting discrete samples
- An increasing number of geometry processing algorithms operate on polygonal meshes
- Success begets success: Polygons are becoming a *lingua franca* of geometry
- Graphics card is polygon drawing machine

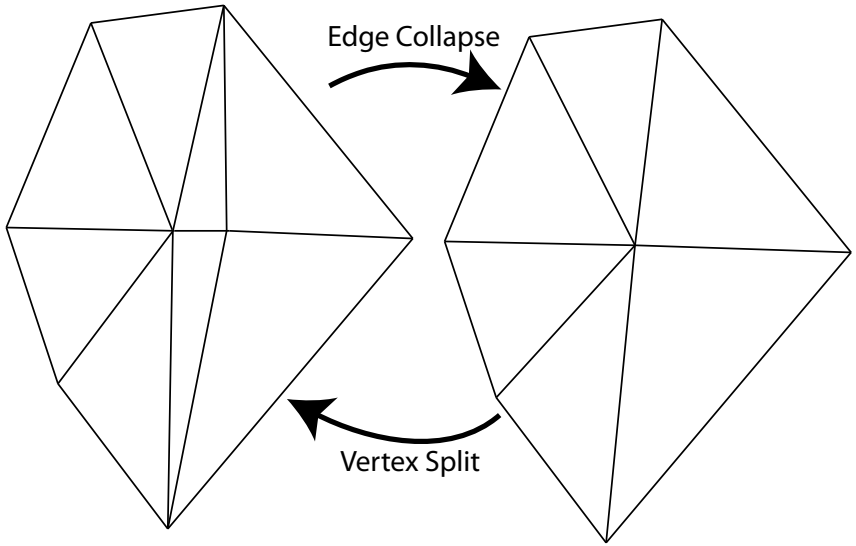


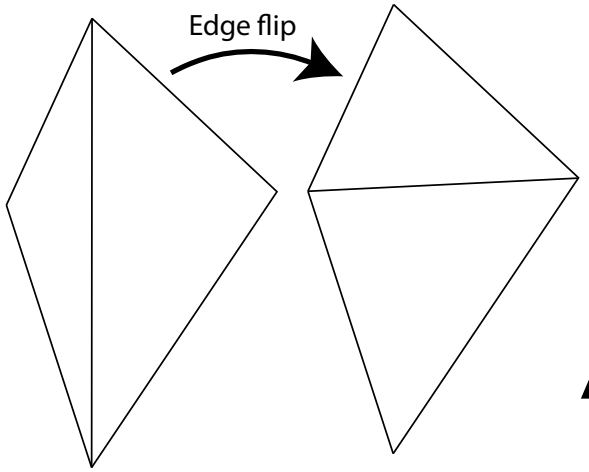
Primitive Operations







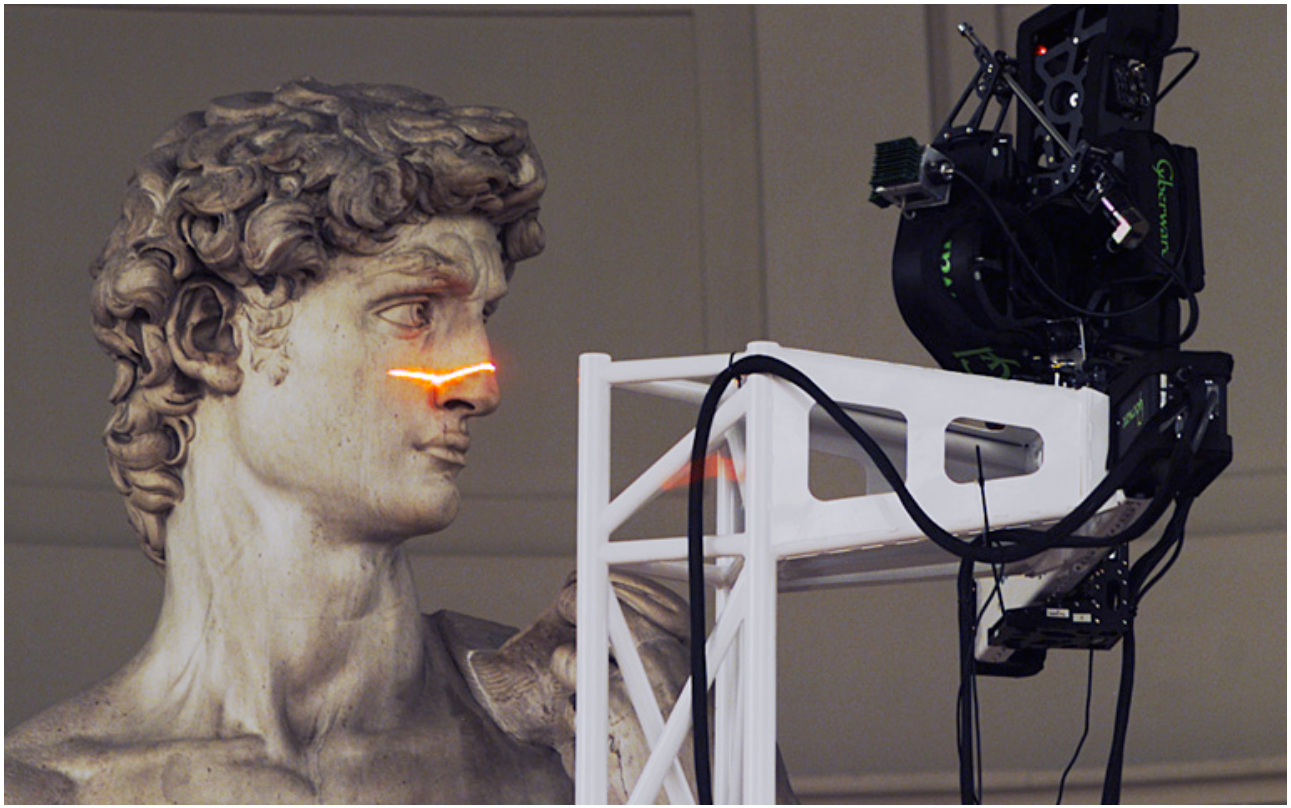




And more ...

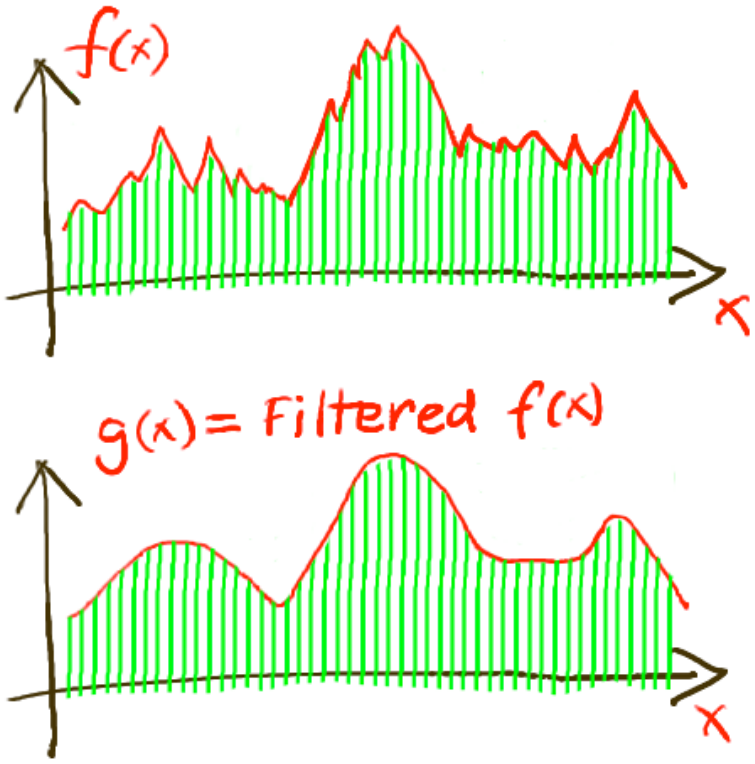
Problems with Meshes

- Oversampling/gigabytes of data
  - most acquired meshes suffer
- Undersampling
  - tiny details ... sharp features
- Both of the above
- Solution: edge collapse



Problems with Meshes

- Noise
  - all acquisition incurs noise
  - We usually assume noise is only in the high frequency details
  - Things get tricky if sharp edges should be retained.
  - solution: vertex move to smooth



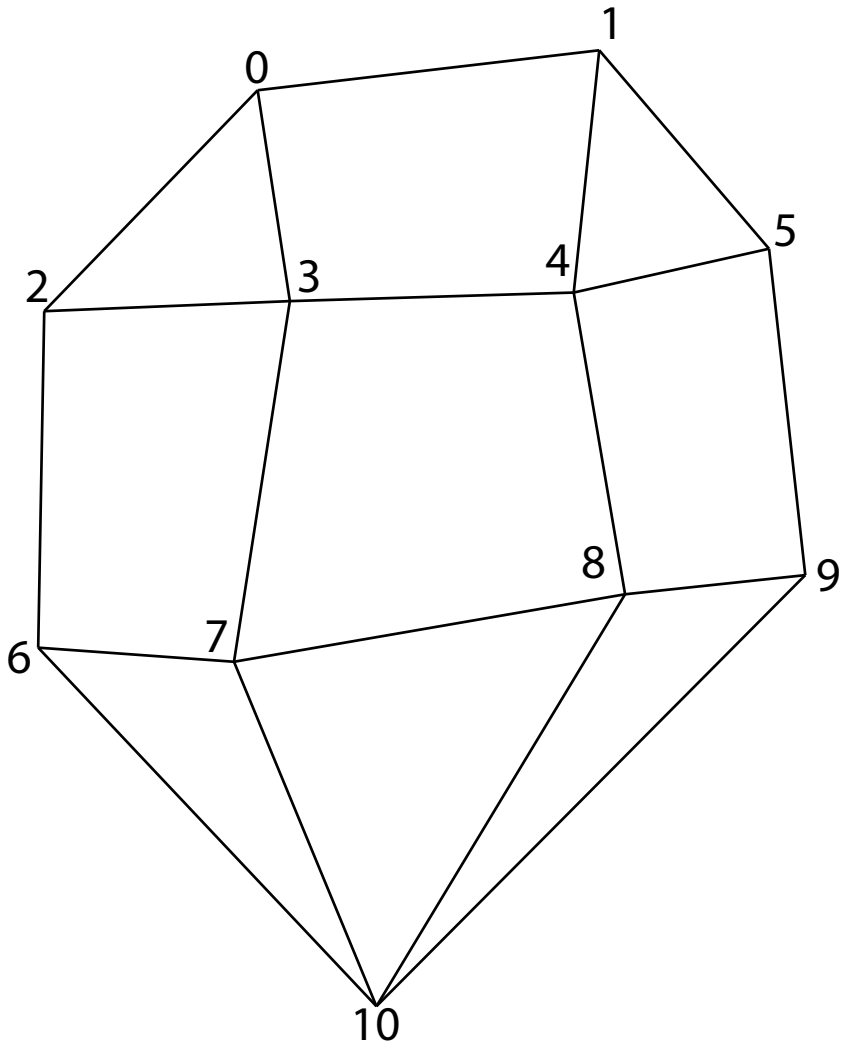
Problems with Meshes

- Disconnected pieces
  - we can only laser scan from a single view
  - Solution: Rigid transformation (move) to align
- Poor vertex connectivity/valence problems
  - arises in variety of situations
  - Solution: edge flip to optimize
- Topological errors
  - May arise when stitching laser scans together
  - Solutions are complicated ...

Representation of Polygonal Meshes

- Indexed face Set
- Indexed face Set (with connectivity data)
- Edge-based data structures
  - Winged edge, quad edge, half edge

Indexed Face Set



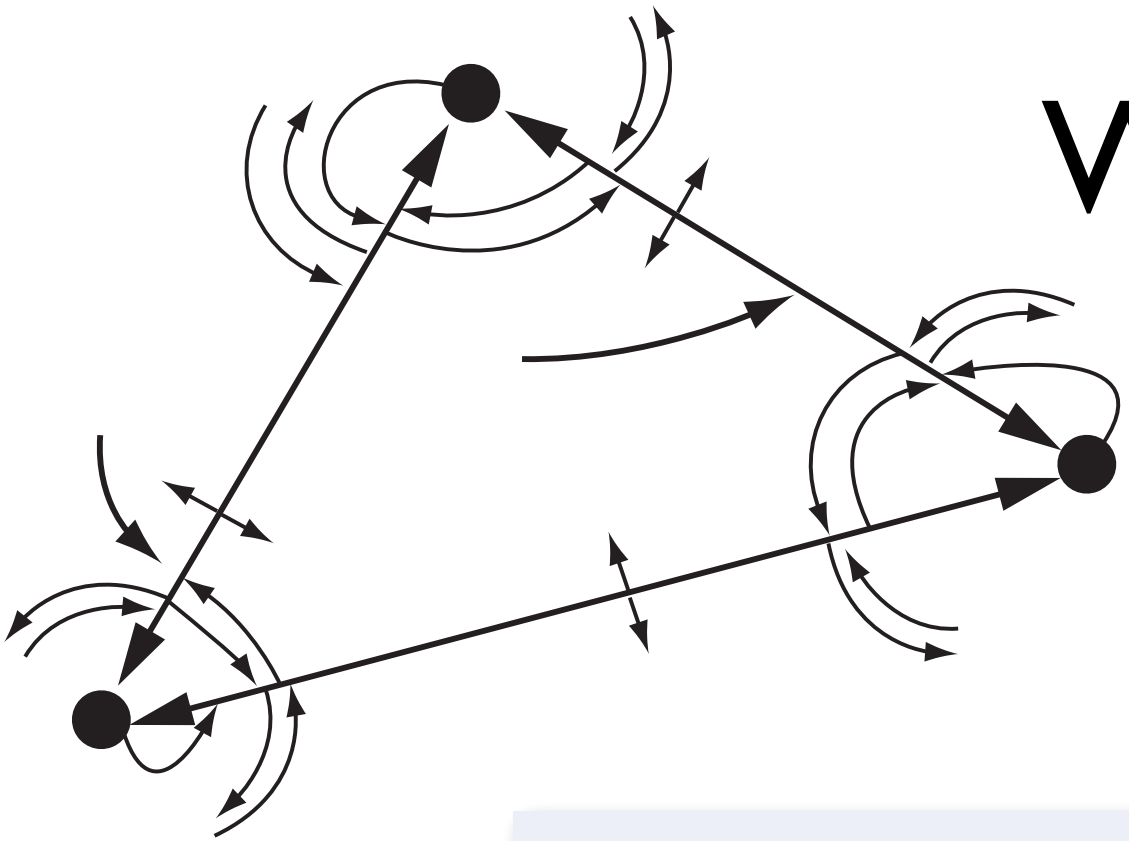
VERTICES

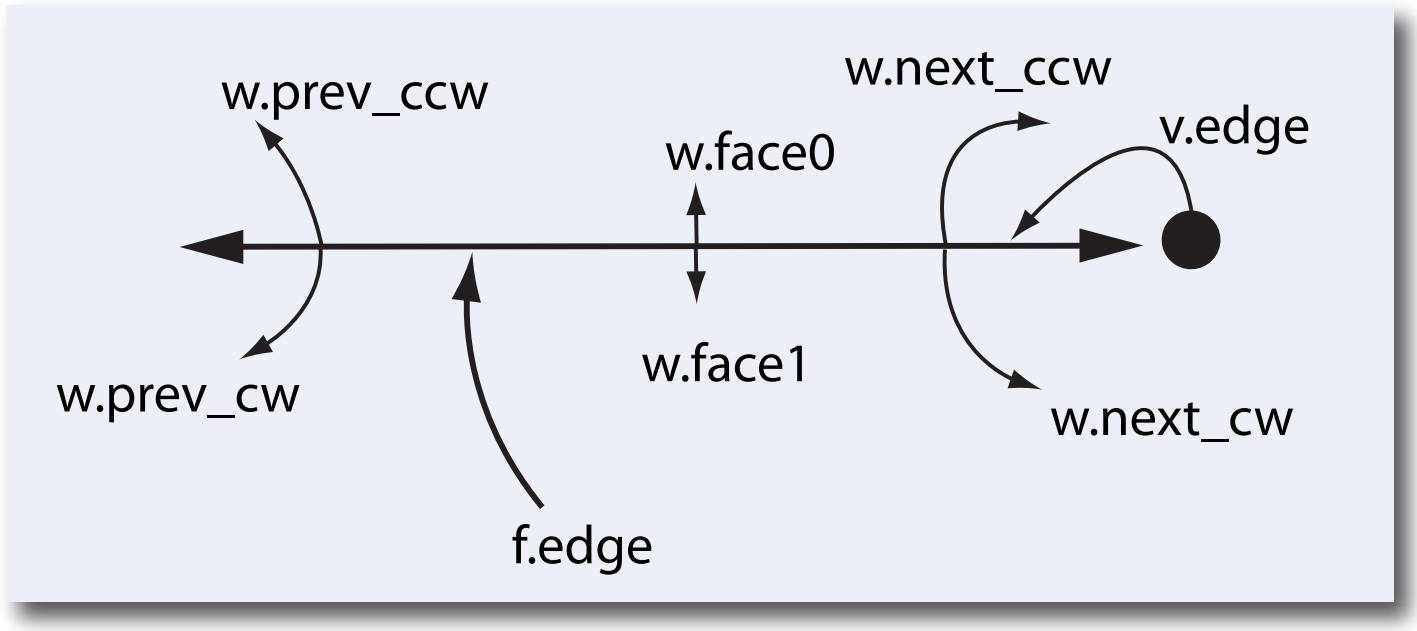
0: (-0.2, 1.5, 0)
1: (1.3, 1.7, 0)
2: (-1.1, 0.4, 0)
3: (0.0, 0.45, 1)
4: (1.1, 0.5, 1.2)
5: (2.1, 0.75, 0.2)
6: (-1.2, -1,0.01)
7: (-0.3, -1.2,2)
8: (1.3,-0.9, 3)
9: (2.0 -0.8,1.2)
10: (0.4, -2.1, -1.1)

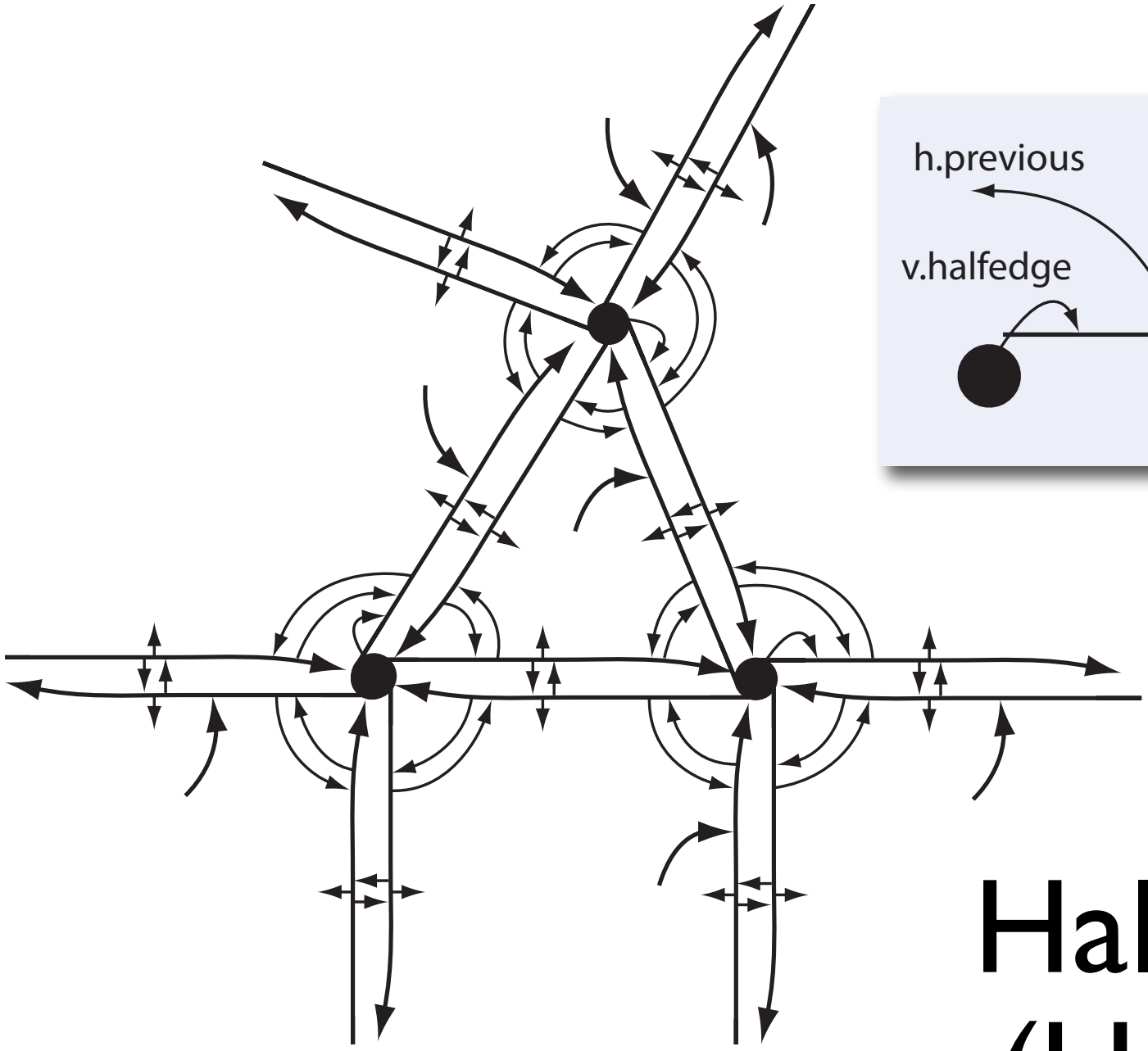
FACES

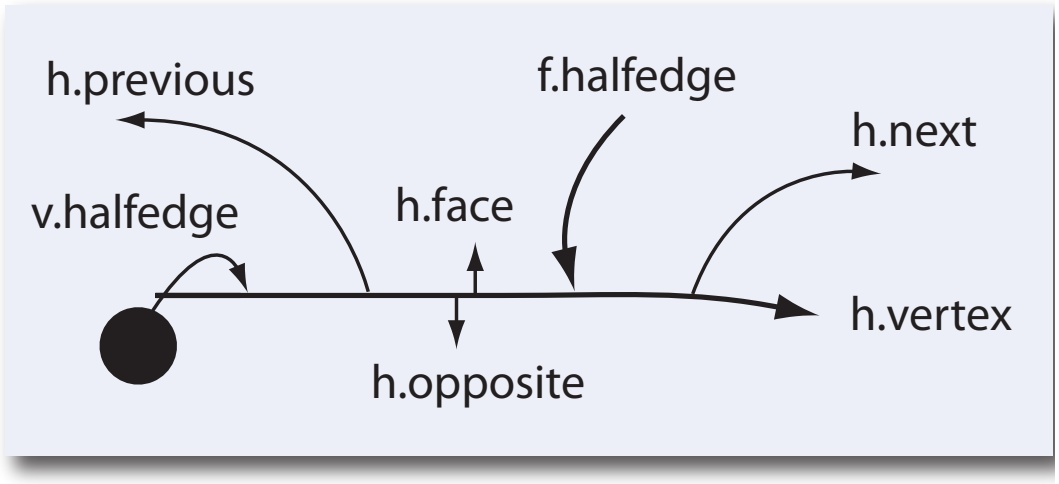
0: 0,2,3
1: 0,3,4,1
2: 1,4,5
3: 2,6,7,3
4: 3,7,8,4
5: 4,8,9,5
6: 6,10,7
7: 7,10,8
8: 8,10,9

Winged Edge




w.prev_ccw
w.next_ccw
v.edge
w.face0
w.face1
w.prev_cw
w.next_cw
f.edge





Half Edge (Hmesh)

Advantages of the Half Edge Rep

- Contains all connectivity information
- Represents general polygonal meshes
  - not just triangles
- No conditionals when circulating around a vertex or a face
  - unlike winged edge