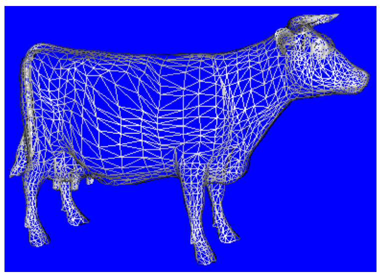
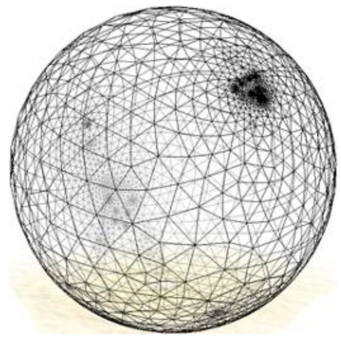
Compressing Connectivity





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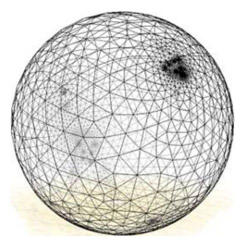
Compressing Connectivity



- Encode mesh structure
  - adjacency + orientation
- *User can control traversal order => order (+ info stored) define encoding*
- Compression = Utilize redundancy
  - In mesh
    - Face has 3 vertices
    - Most edges have 2 faces => Edgebreaker
    - *Most vertices have valence 6 => TG coder*

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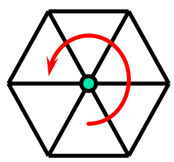
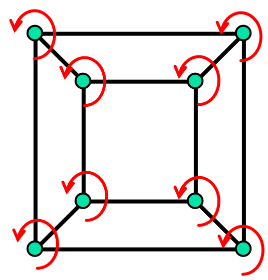
TG Connectivity Coder: Intuition

demo

- Vertex based traversal
- Edges incident on any vertex can be ordered consistently counter-clockwise
  - True in any planar graph
  - Determines order





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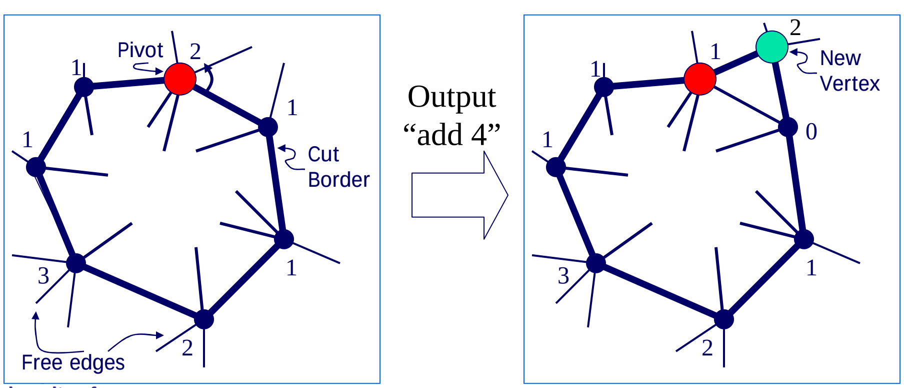
TG Connectivity Coder

- Grow encoded (decoded) region
- Use spiral-like border extension
  - add <valence>



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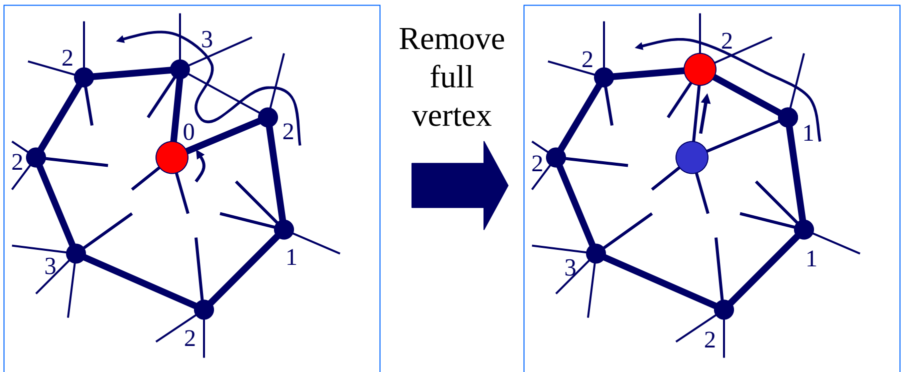
TG Connectivity Coder



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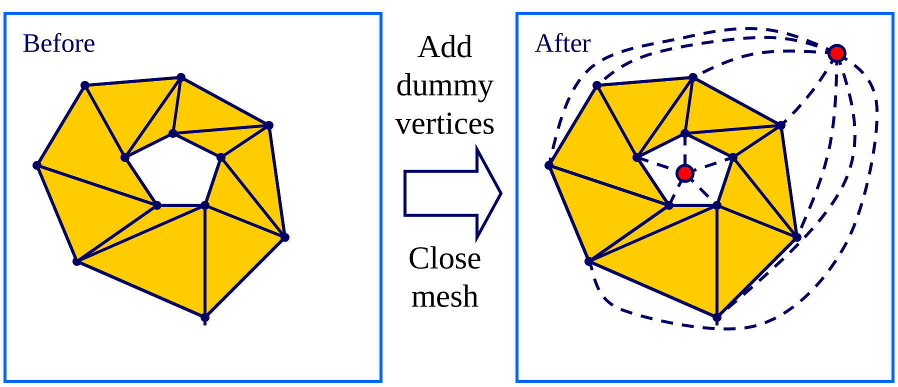
TG Coder – Special Cases

- Boundaries



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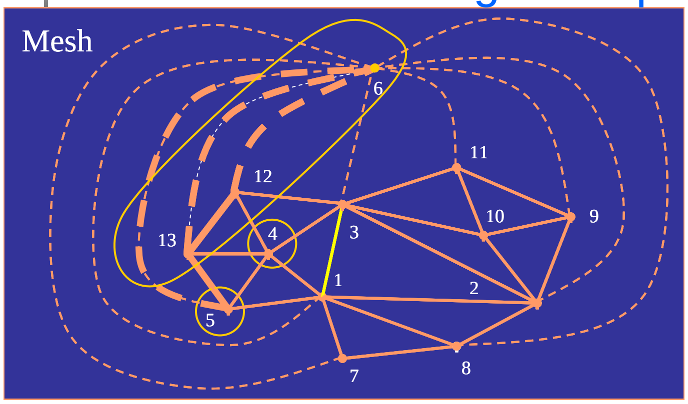
TG Encoding Example



Stack

6-12-13

Output

```
- ActiveList.RemoveFullVertices();  // remove exhausted vertices
                                    // the last triangle removed
                                    // all triangles of Mesh are visited
```

TG Encoding Algorithm: Output

- Output command sequence:

  Add 7, Add 6, Add 7, Add 5, Add 4
  Add dummy 10
  Add 3, Add 4, Add 4, Add 4, Add 4, Add 4, Add 4

- Entropy compressed bitstream:
  - Huffman code:

Add 4	Add 7	Add 5	Add 6	Add dummy 10	Add 3
1	00	0100	0101	0110	0111

  - Resulting in 27 bits = 2.25 bits/vertex

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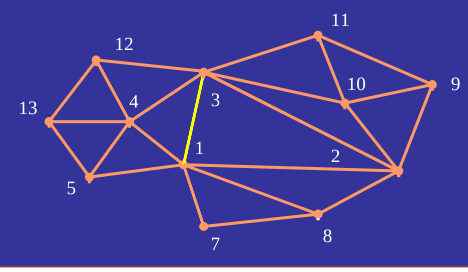
TG Decoding Example

Mesh



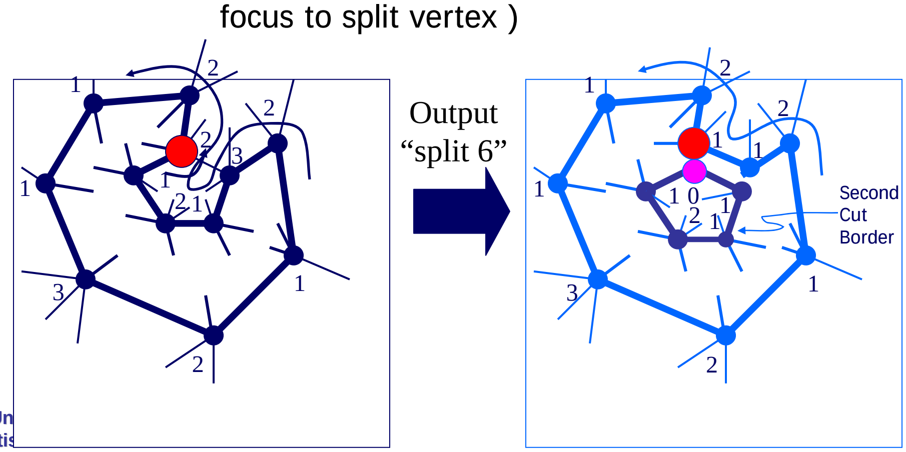
Stack

Input

```
- while Mesh.HasDummy()                // handle boundaries
   - Vertex dummy:= Mesh.GetDummy(); // pick a dummy vertex
   - Mesh.Remove(dummy);              // remove dummy and all its incident edges
```

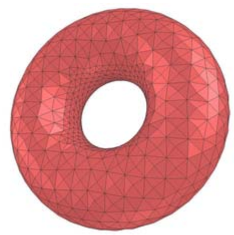
TG Coder – Special Cases

- Cut-border intersects itself:
  - split <offset>
    - Offset = distance (sum of free counts from focus to split vertex)



More TG Special Cases

- Genus > 0: Merge operation required
  - Occurs when two different cut-borders intersect



- Non-manifolds: Cut into manifold pieces

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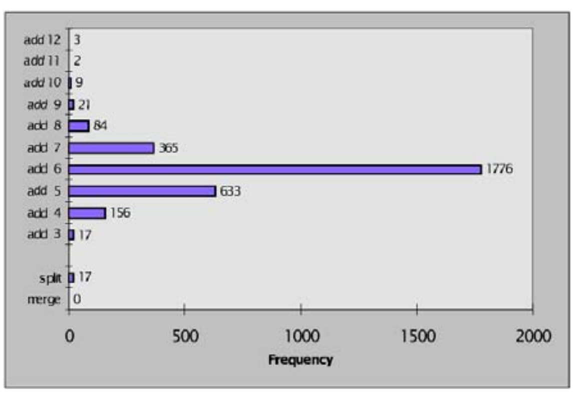
Typical Command Distribution



Coded to 2.0 bits/vertex

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TG Algorithm Performance

- Disadvantages:
  - No theoretical upper bound on code length
- Advantages:
  - Gives **very good** compression rates (approx 2 bits/vertex) on typical meshes
  - Gives excellent rates on highly regular meshes

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Lower Bound on Connectivity Coding Performance

- **Theorem (Tutte, 1960):** Asymptotically (as $n \to \infty$) number of different planar triangulations on n vertices tends to

$$\Psi_n \approx \frac{1}{16}\sqrt{\frac{3}{2\pi}}\, n^{-\frac{5}{2}} \left(\frac{256}{27}\right)^{n+1}$$

- Entropy of this (uniform) distribution per vertex is

$$\frac{\log_2(\Psi_n)}{n} \to \log_2\left(\frac{256}{27}\right) \approx 3.24\ldots \quad \text{bits/vertex}$$

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