
Mesh Errors

Survey on Detection and Correction

Daniel Veleba, Petr Felkel

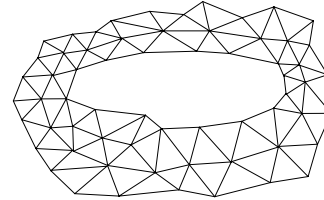
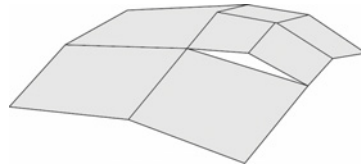
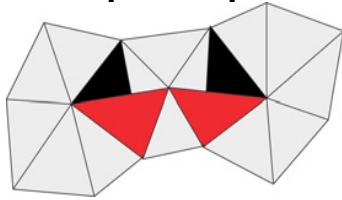


CTU Prague

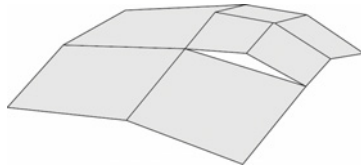


Origin

- Improper triangulation



- Imprecise computations

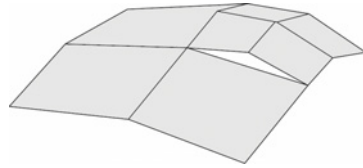


- Export filters

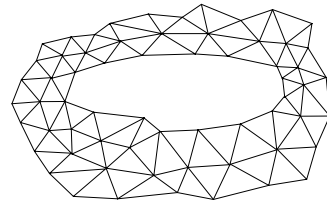


Overview

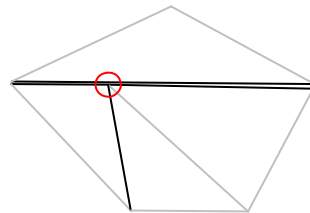
- Cracks



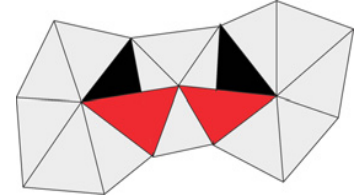
- Holes



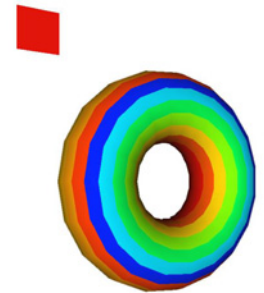
- T-joints



- Overlaps



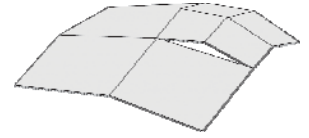
- Zero Volume Parts



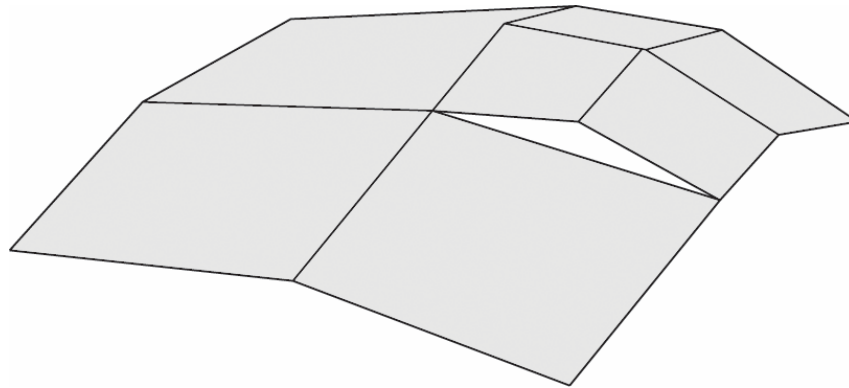
- Swapped Normals



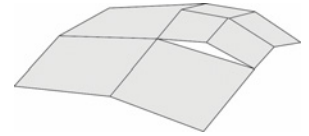
Cracks



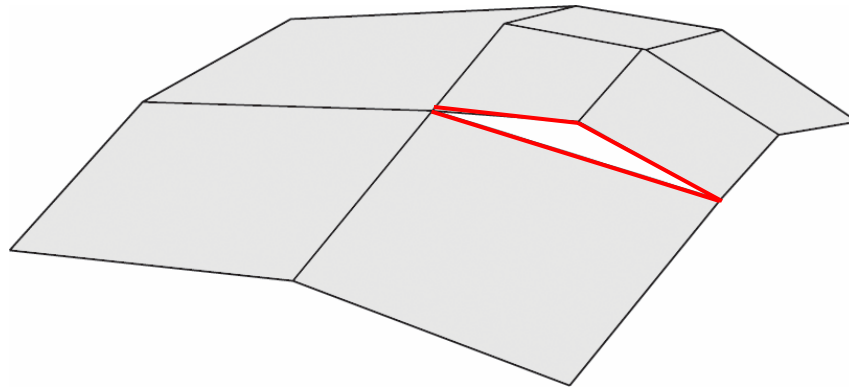
Small gaps in the model surface



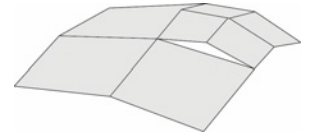
Cracks - detection



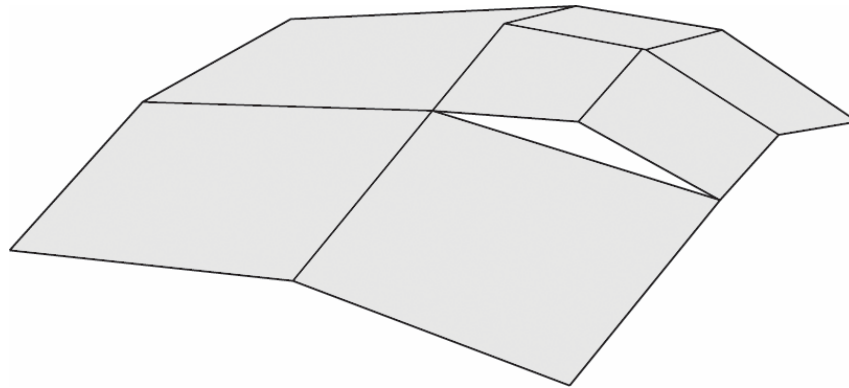
Delimited by boundary edges



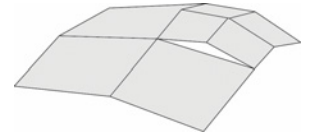
Cracks - correction



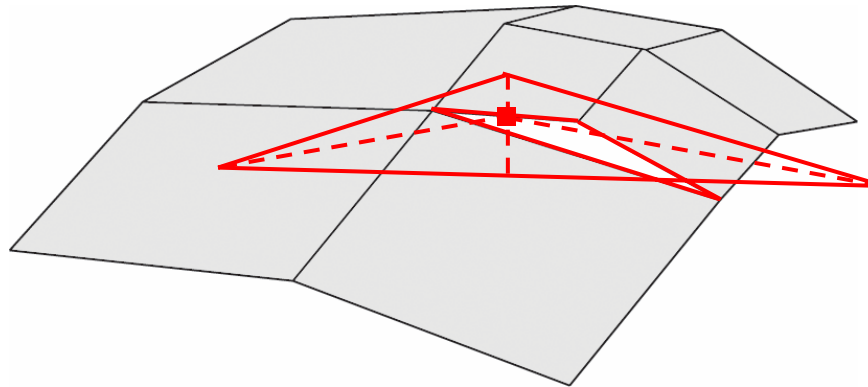
Retriangulate the rougher face



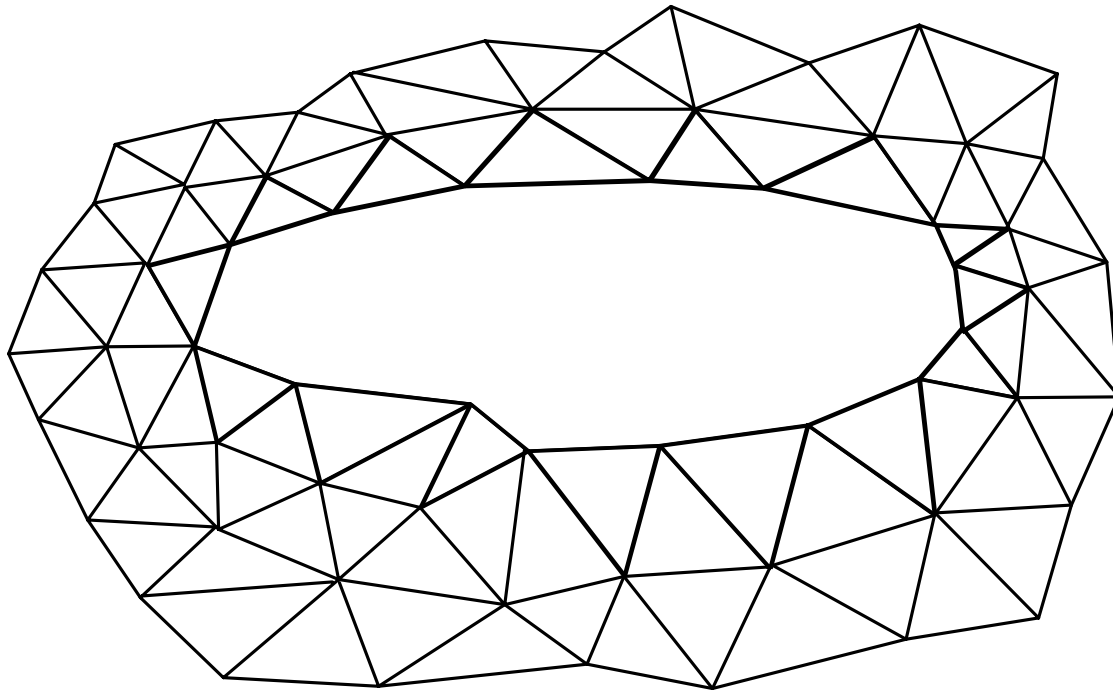
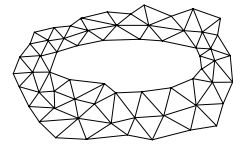
Cracks - correction



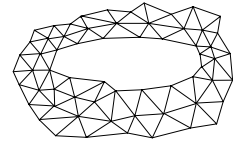
[Borodin02]: vertex-edge contraction



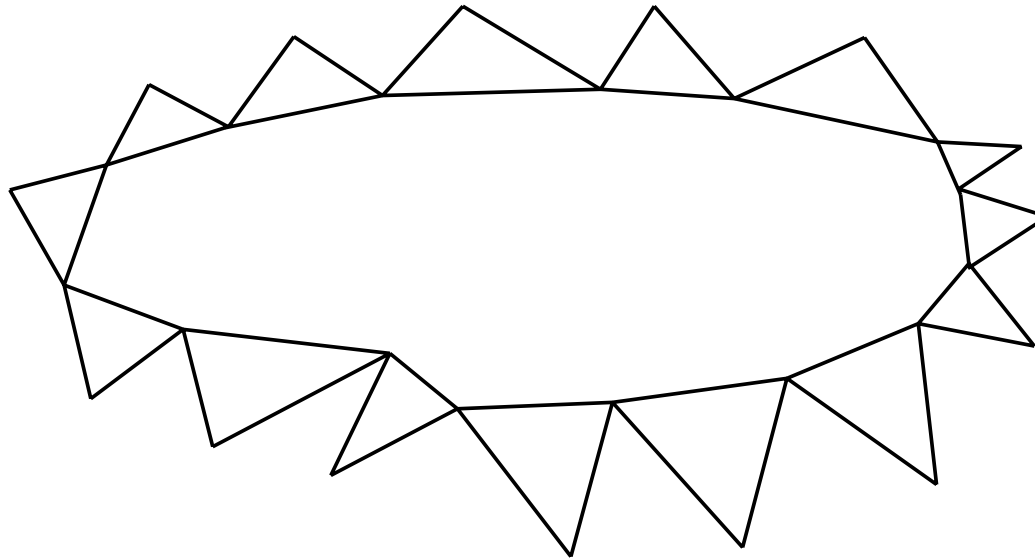
Holes



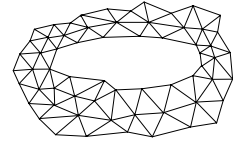
Holes - detection



Delimited by boundary edges similarly to cracks

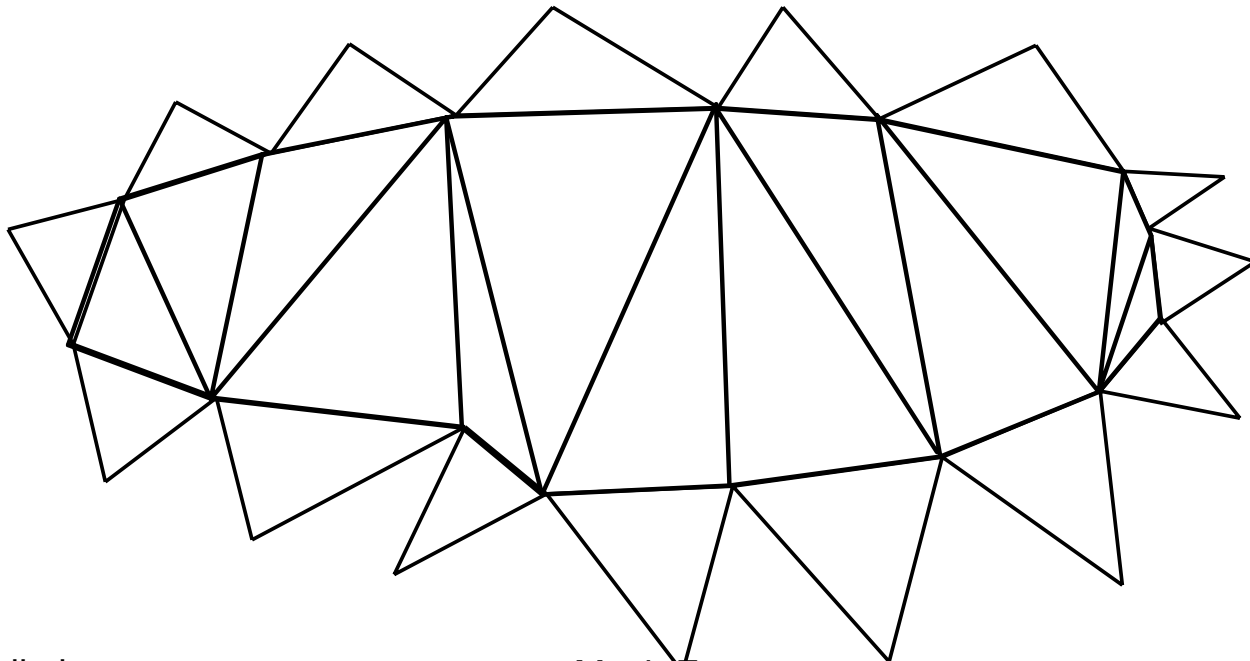


Holes - correction

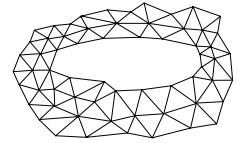


[Liepa03]:

1. Generate a patch that minimizes a weight function (minimal dihedral angle and area)

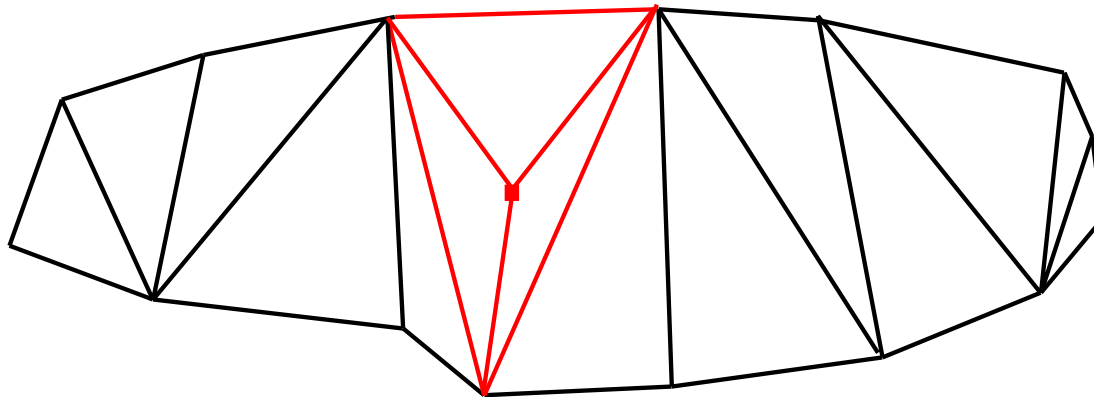


Holes - correction

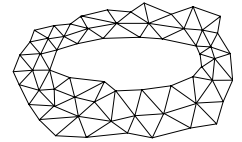


[Liepa03]:

2. Refine the patch using centroids

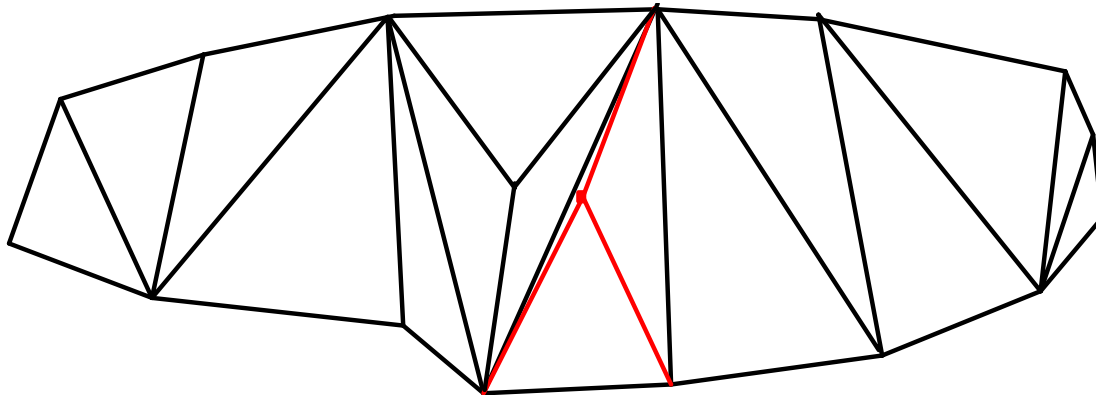


Holes - correction



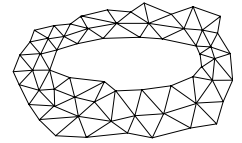
[Liepa03]:

2. Refine the patch...



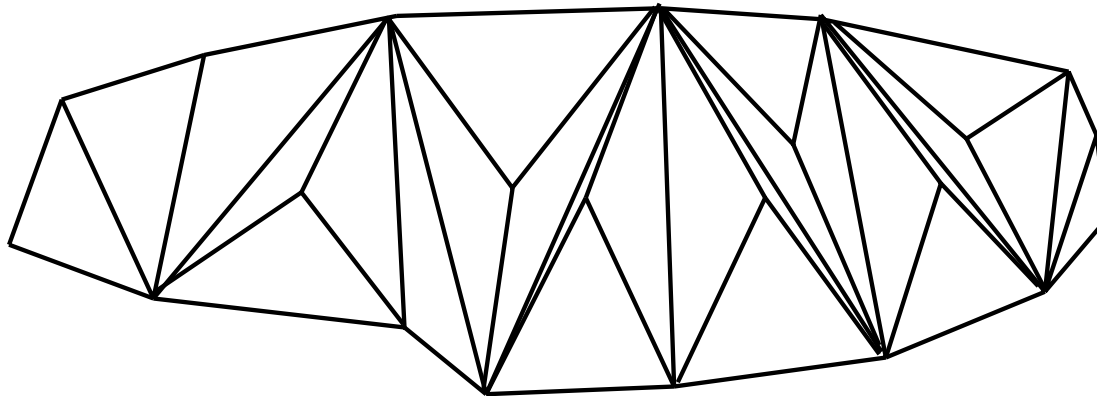
etc...

Holes - correction

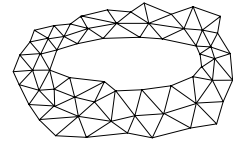


[Liepa03]:

2. Refine the patch...

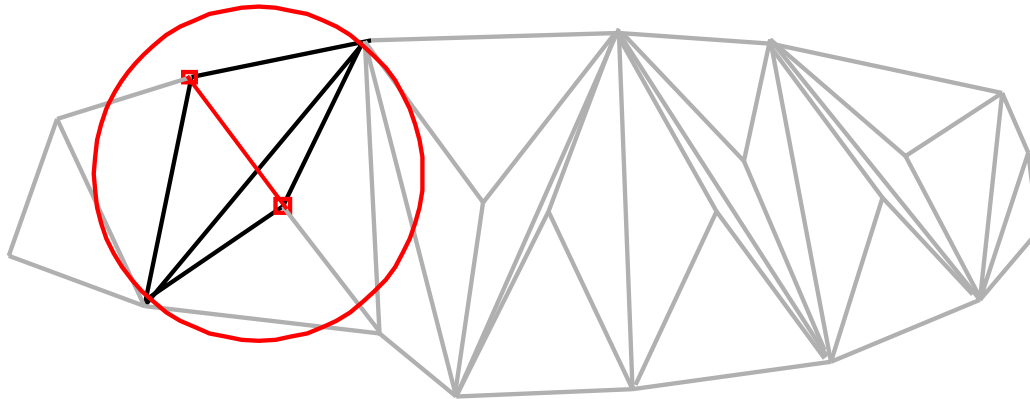


Holes - correction

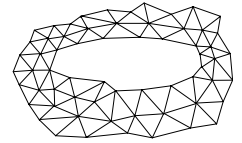


[Liepa03]:

3. Relax inner edges

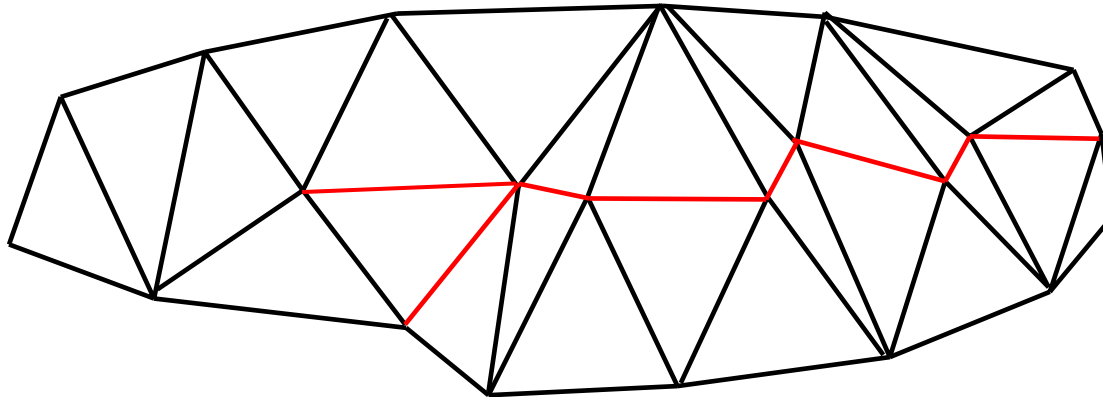


Holes - correction

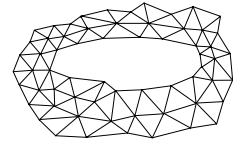


[Liepa03]:

3. Relax inner edges

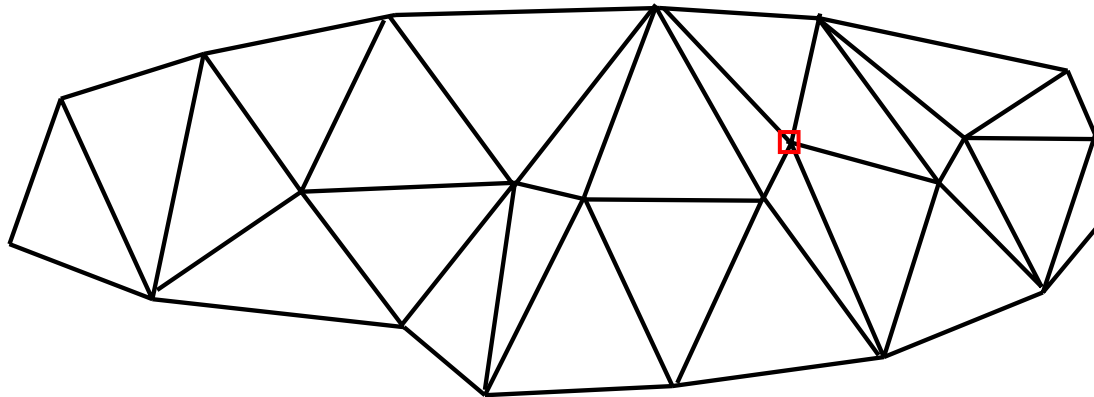


Holes - correction

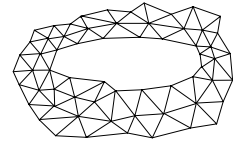


[Liepa03]:

4. Smoothing

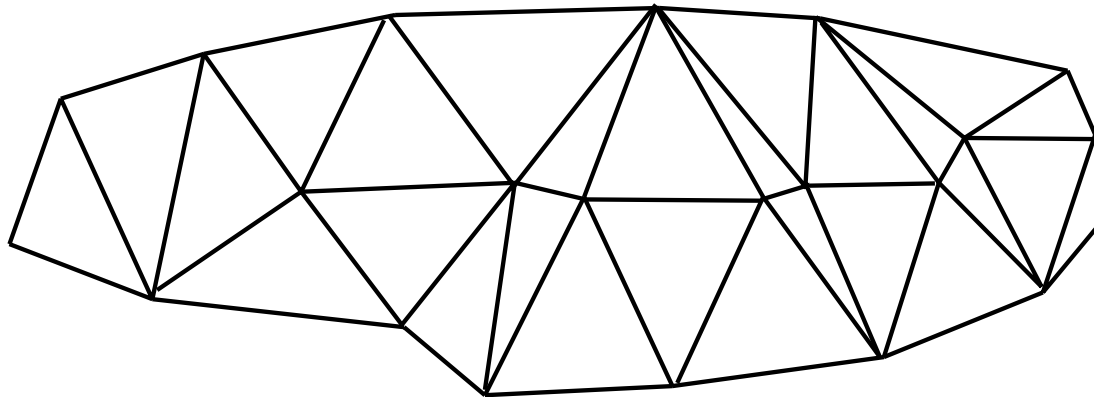


Holes - correction

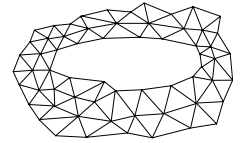


[Liepa03]:

4. Smoothing

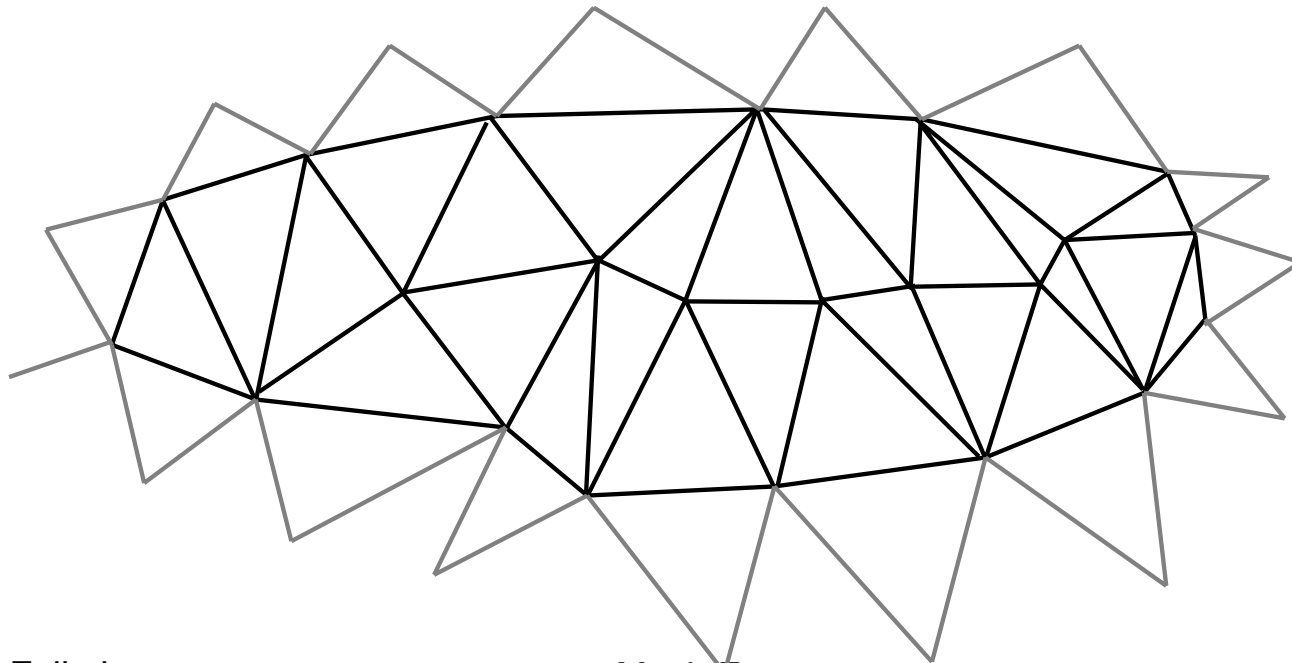


Holes - correction

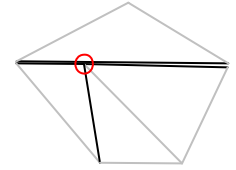


[Liepa03]:

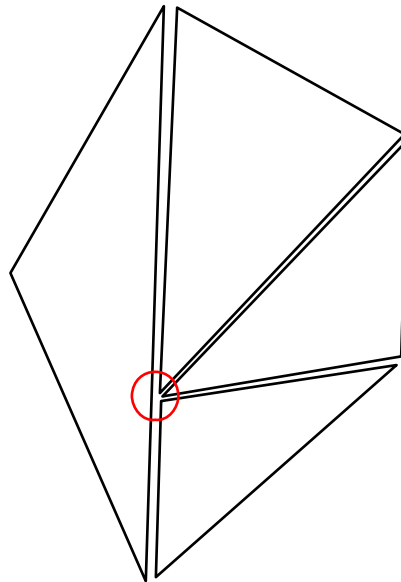
5. Result



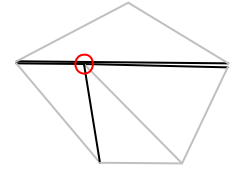
T-joints



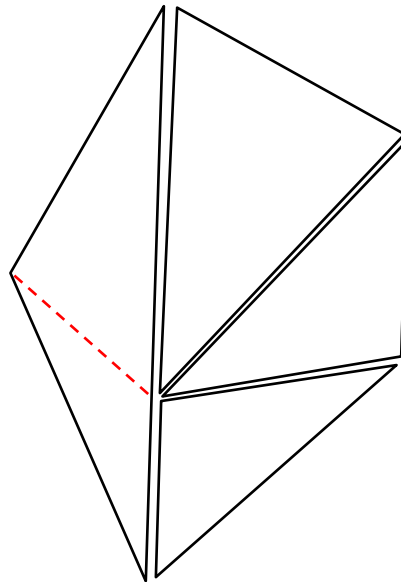
One face neighbors with more faces on one edge



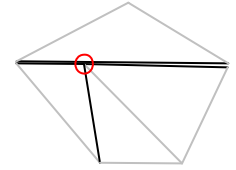
T-joints - correction



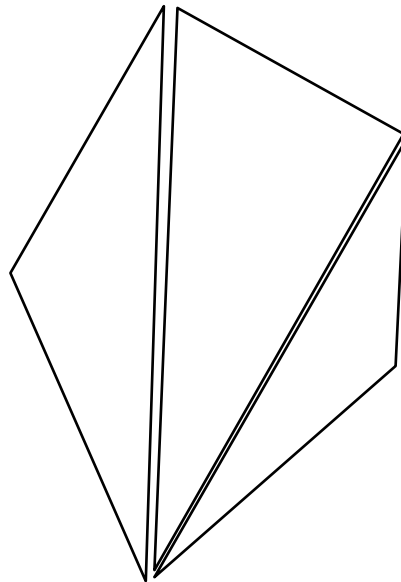
Not optimal



T-joints

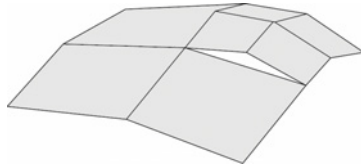


Better

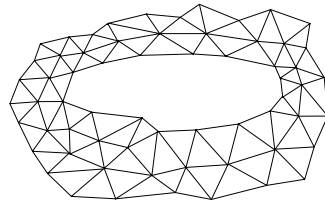


Overview

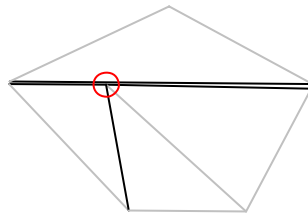
- Cracks



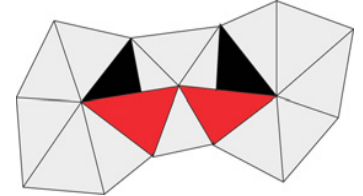
- Holes



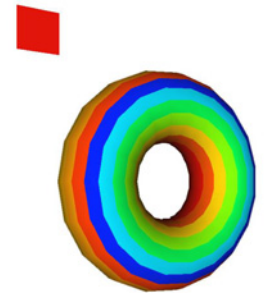
- T-joints



- Overlaps



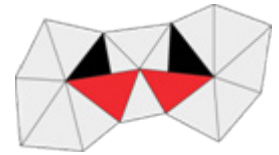
- Zero Volume Parts



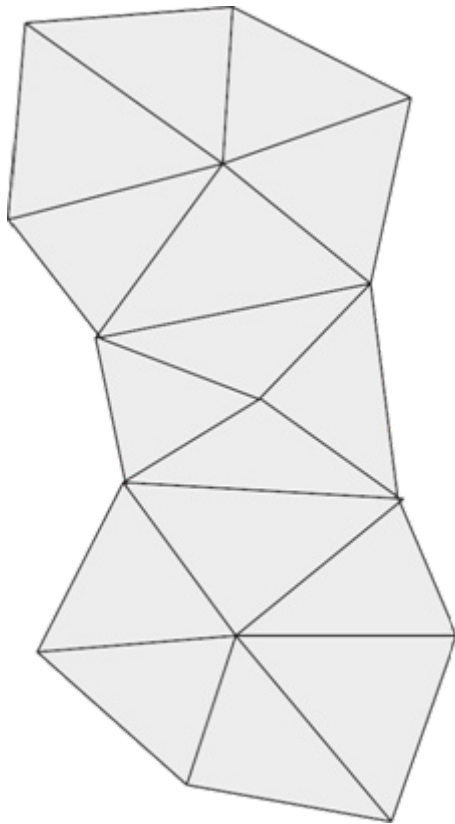
- Swapped Normals



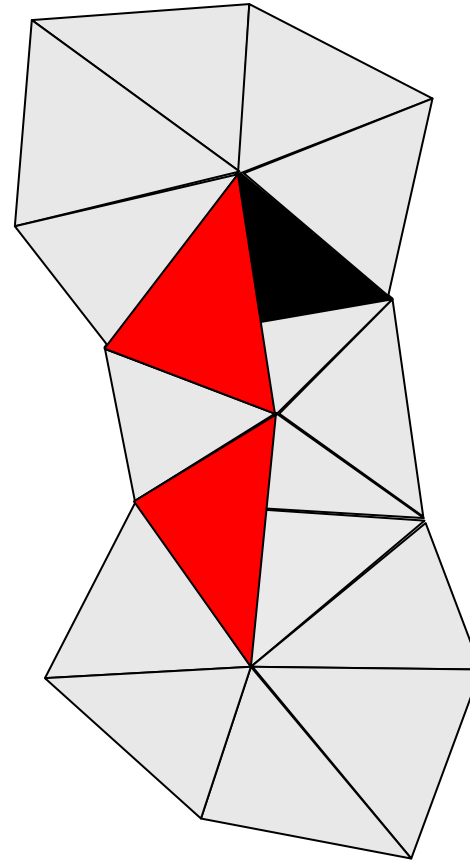
Overlaps



The red triangles overlap the mesh

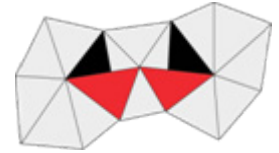


Original mesh



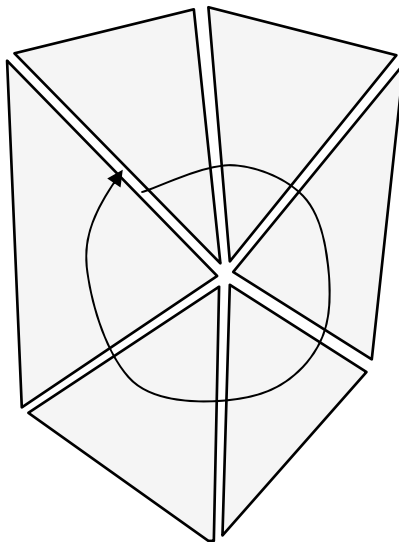
Erroneous mesh

Overlaps - detection

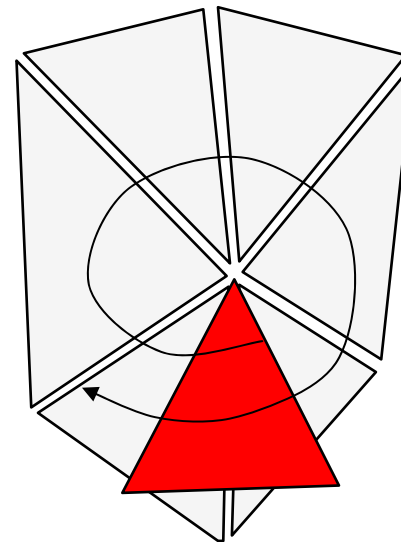


[Var05]: Triangle fans for vertices adjacent to boundary edges

$2\pi \rightarrow \text{OK}$



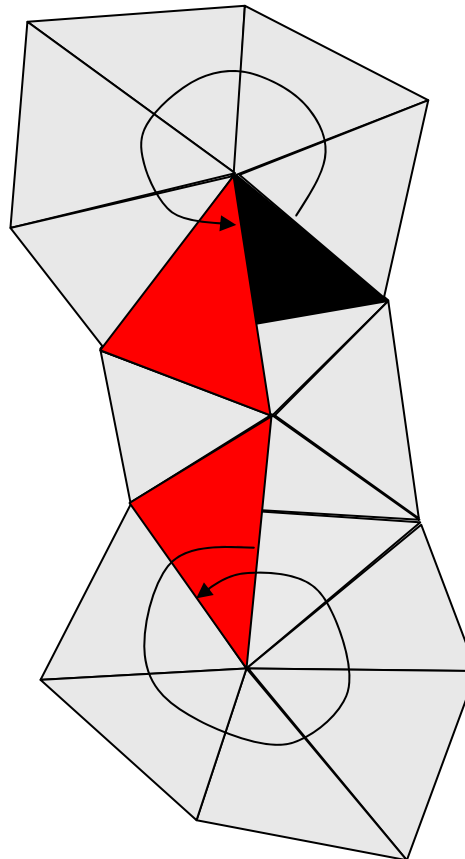
$\neq 2\pi \rightarrow \text{NOT OK}$



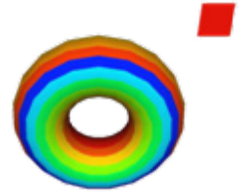
Overlaps - correction



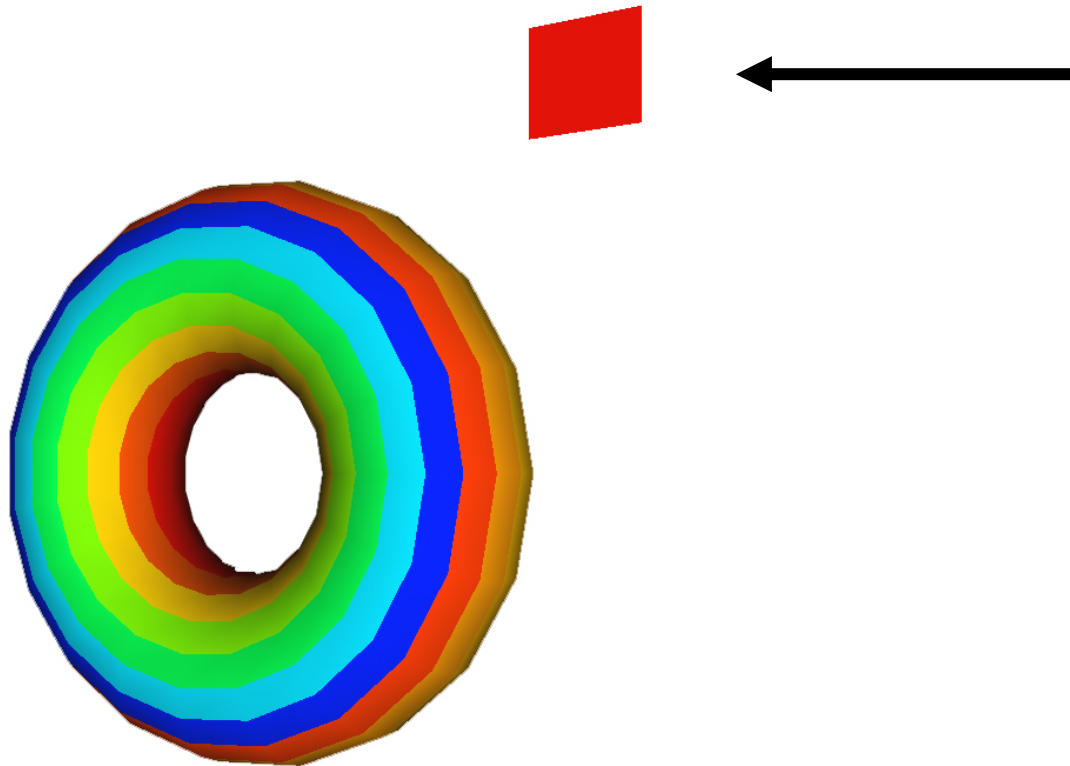
Delete the redundant triangle (and fill the gap)



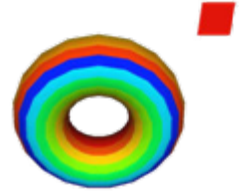
Zero Volume Parts



Model parts that do not enclose any volume

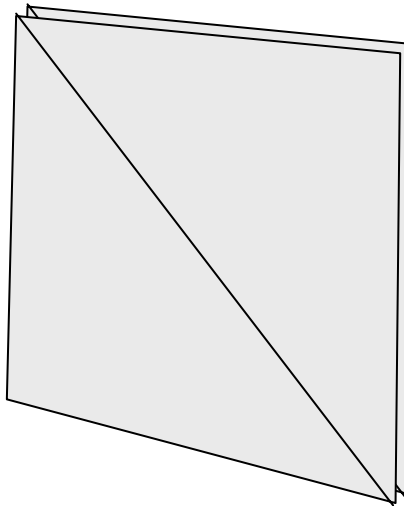


Zero Volume Parts - detection

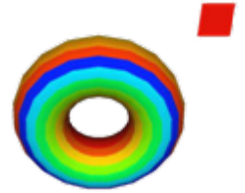


- [Bøhn95] – only pairs of identical faces.

ZVP

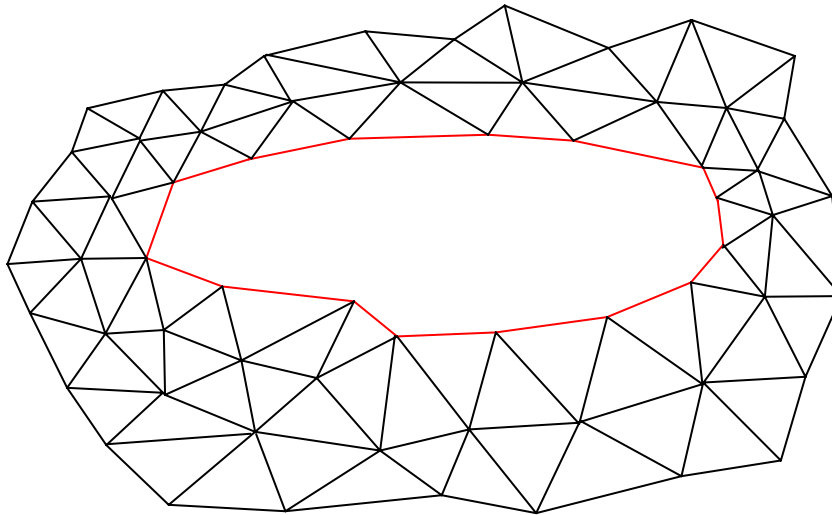


Zero Volume Parts - detection

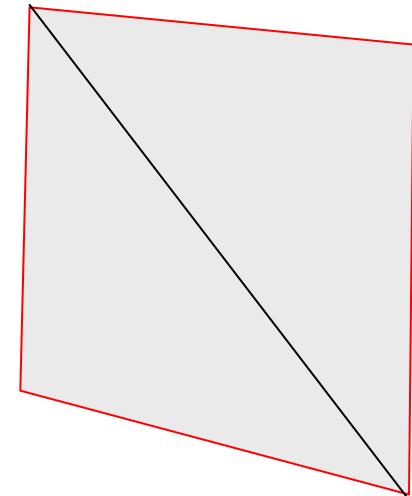


- More generally: Using boundary edges.
How to distinguish from holes?

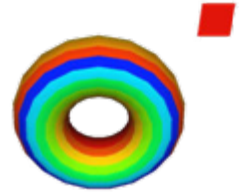
Hole



ZVP



Zero Volume Parts - detection



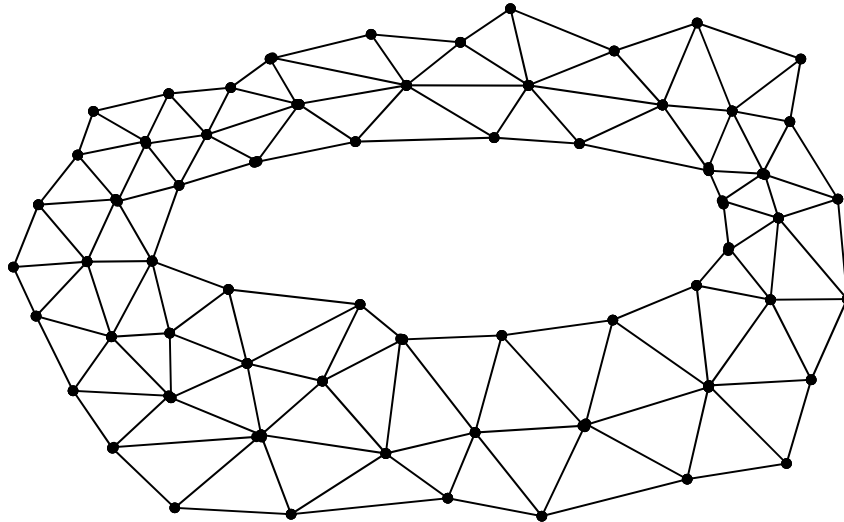
- How to distinguish from holes?

Count the number of the parts' vertices

→

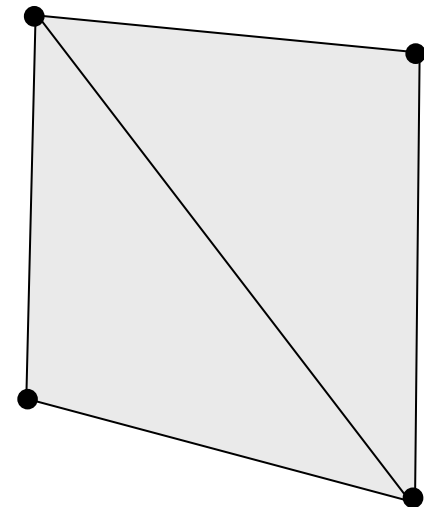
$> > 4$

Hole

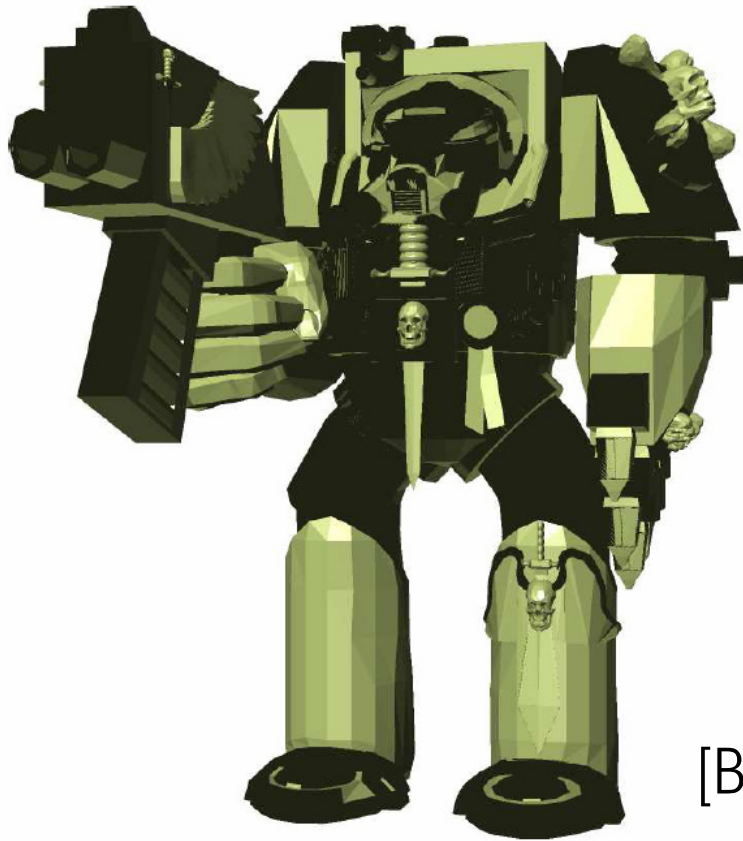


4

ZVP



Inconsistent Normal Orientation

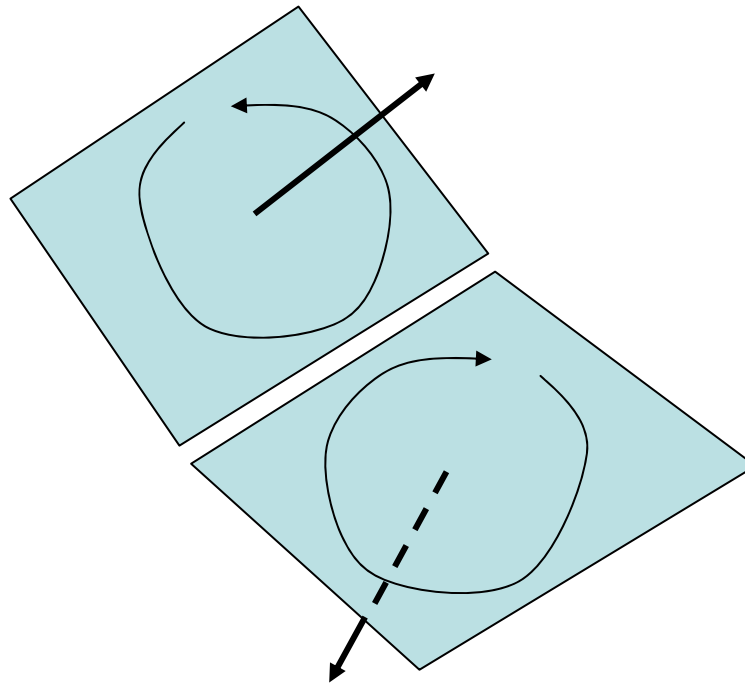


[Borodin04]

Normals - detection



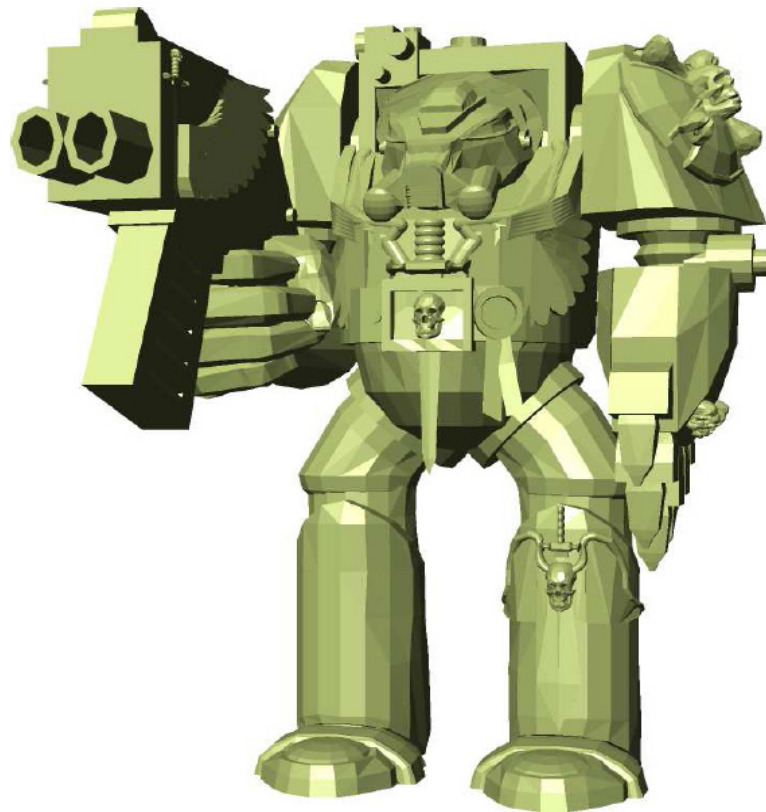
- Faces with different orientation(CW/CCW)



Normals - correction

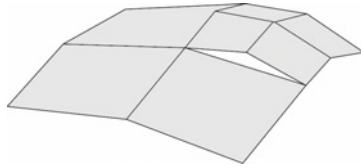


[Borodin04]: Consistency & Visibility

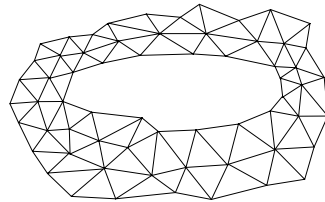


Overview

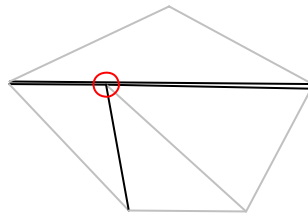
- Cracks



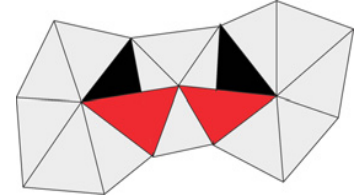
- Holes



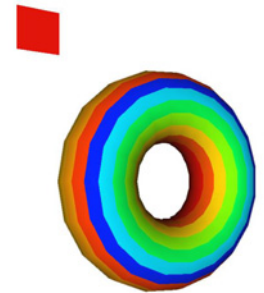
- T-joints



- Overlaps



- Zero Volume Parts



- Swapped Normals



Conclusion

- Detection and correction algorithms for almost all errors,
but
- It's better to have proper methods
 - triangulation, precise computations, export filters that do not produce erroneous meshes

See the paper for the citations