
Normal Meshes

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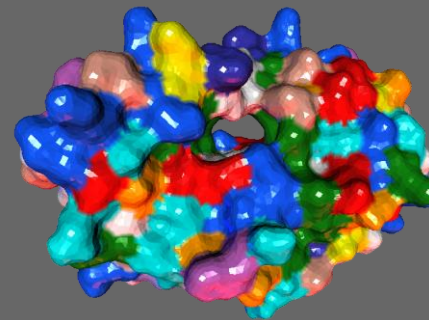
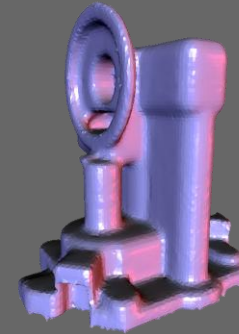
Motivation

Surfaces

- highly detailed meshes

Scanned meshes

- manufacturing
- entertainment
- science



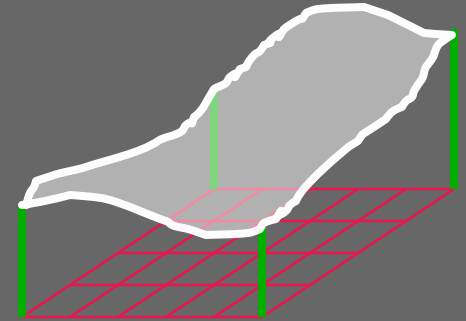
Efficient and compact representation



Surfaces

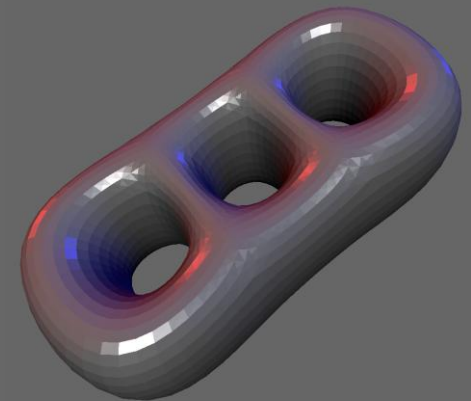
Height fields, terrains

- $f(u,v)$
- one float / vertex



3d surfaces

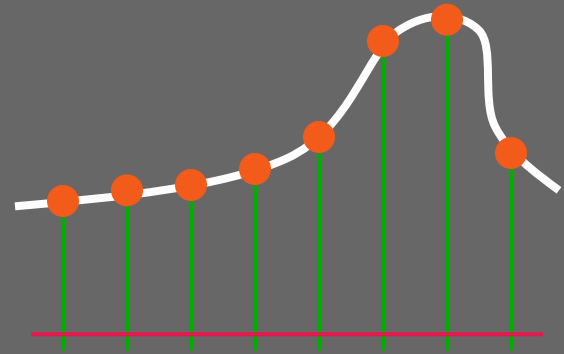
- $x(u,v), y(u,v), z(u,v)$
- three floats / vertex



Curves

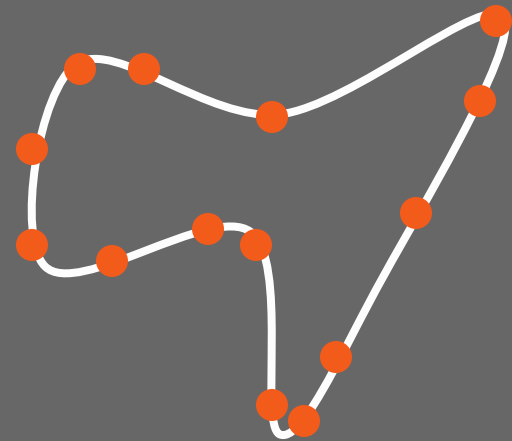
Function

- $f(u)$
- one float / vertex



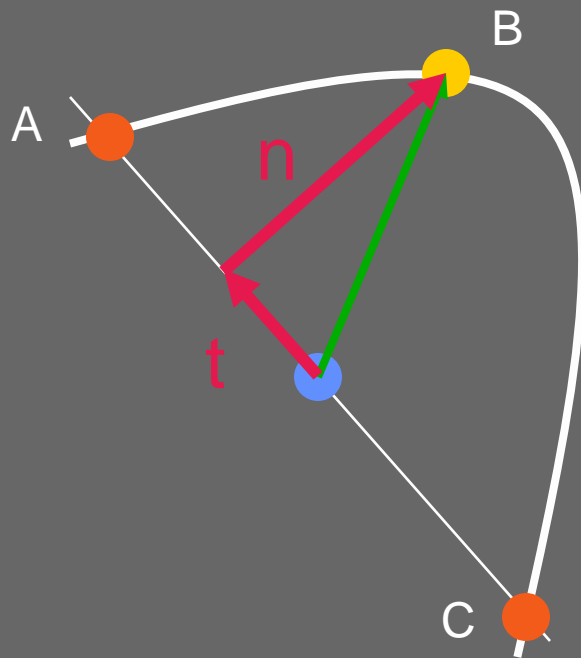
Curve

- $x(u), y(u)$
- two floats / vertex

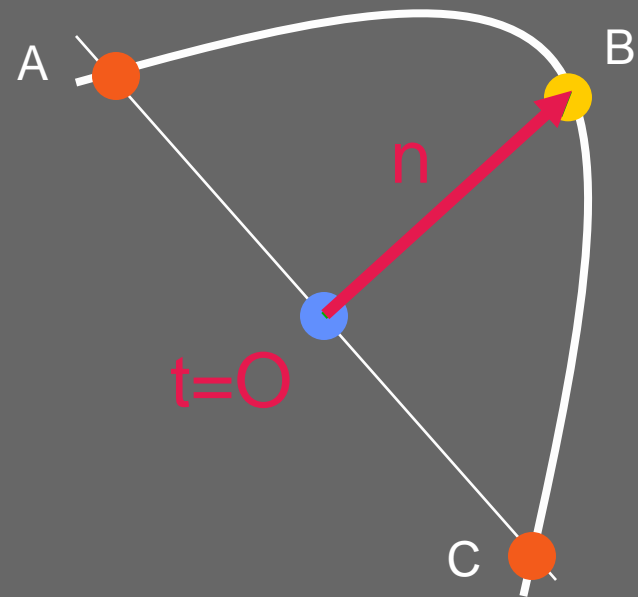


Local Detail (x,y)

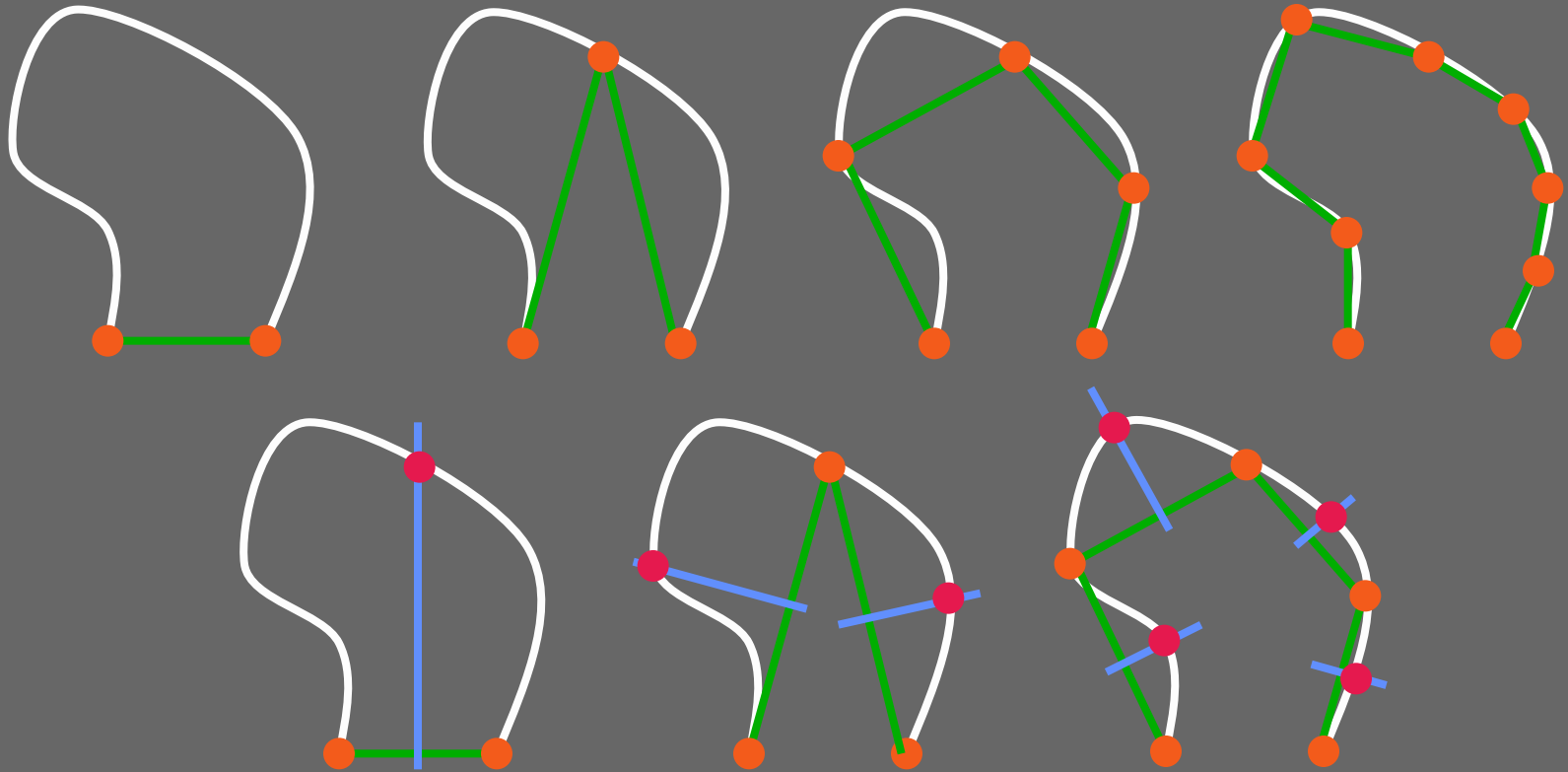
(t,n) stored



One float!



Simple Algorithm



Our Contribution

Normal meshes

- multiresolution
- geometry with one float per vertex

Conversion algorithm

- irregular to normal

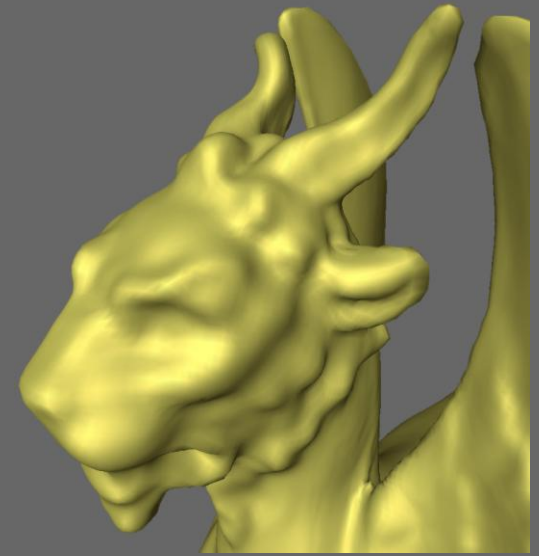
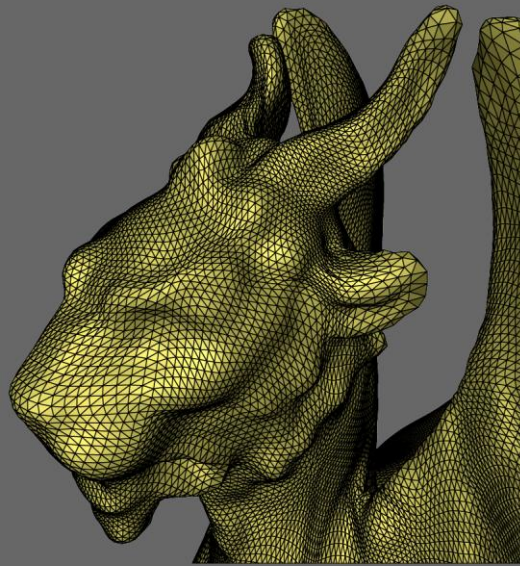
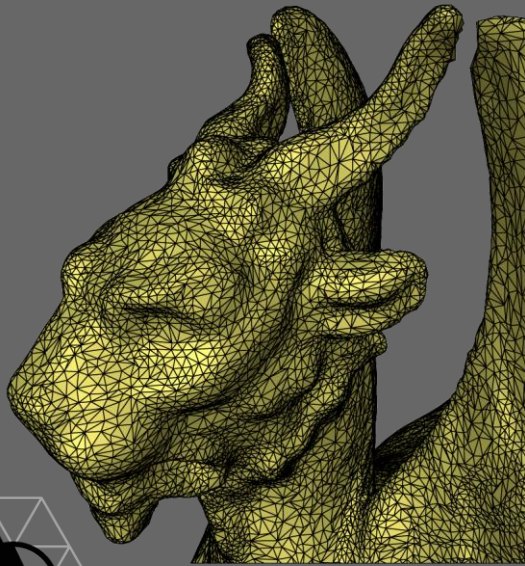


What is in a mesh?

Connectivity + Vertices

sample locations

geometry



Normal Meshes

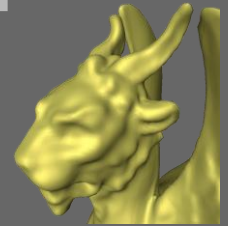
Mesh

Normal mesh

■ geometry



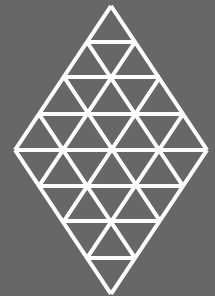
same



■ connectivity



semi-regular



■ sample locations



optimal
one float/vertex



Related work

Remeshing

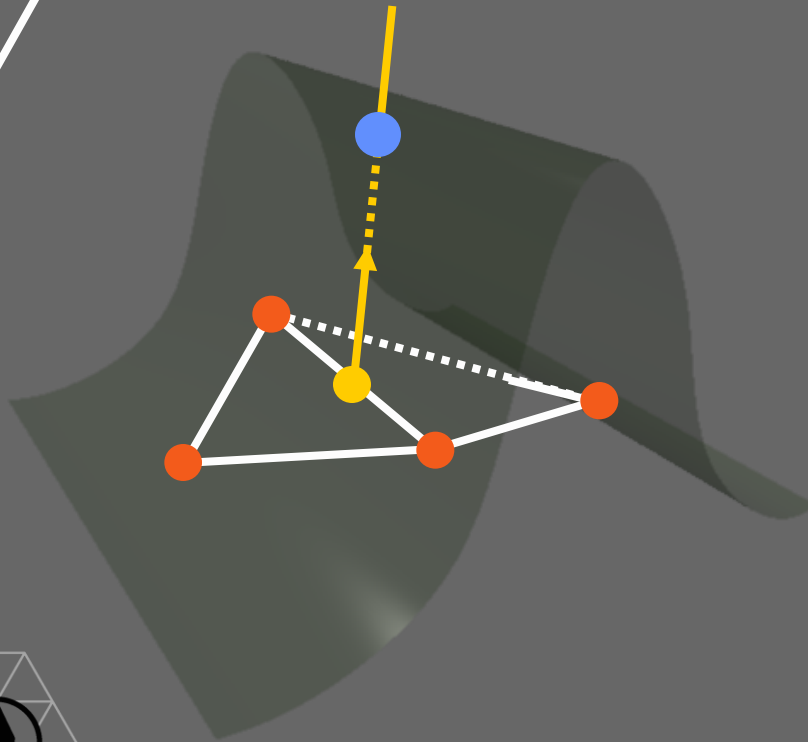
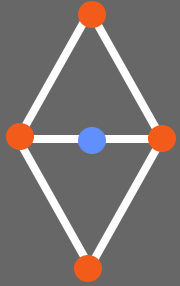
- Hoppe et al. '94
- Eck et al. '95
- Krishnamurthy, Levoy '96
- Lee et al. '98

Siggraph 2000

- Lee et al. , Khodakovsky et al.



Piercing



Storage

- one float/vertex

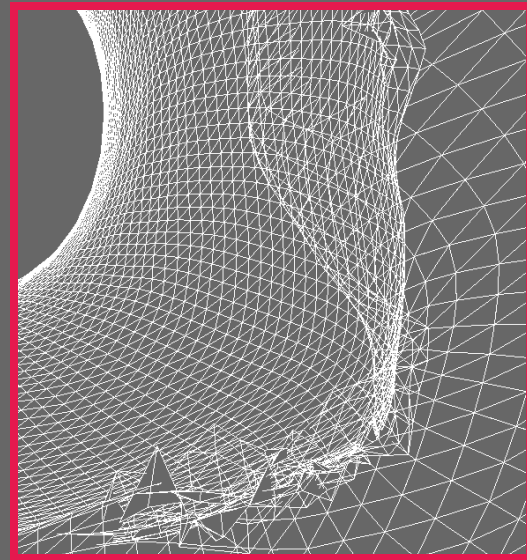
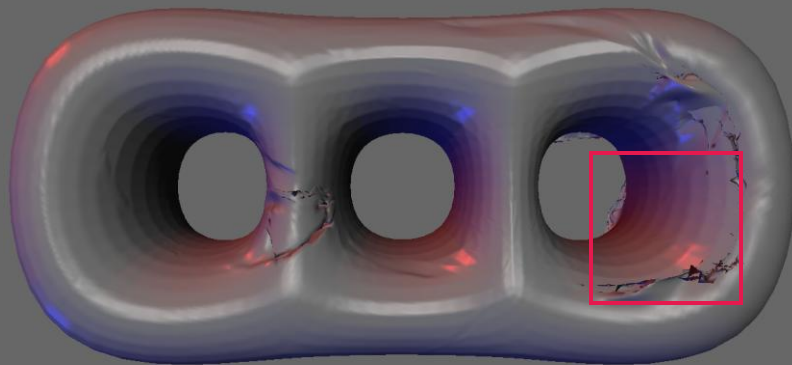
Naïve algorithm:

- start with coarse mesh
- pierce recursively



But ...

Naïve piercing does **not** work!



We need

- more control over the process



Algorithm

1. Initial patch layout

- progressive hierarchy
- global relaxation

2. Remeshing procedure

- piercing step
- one-to-one correspondence



Patch Layout

Base mesh

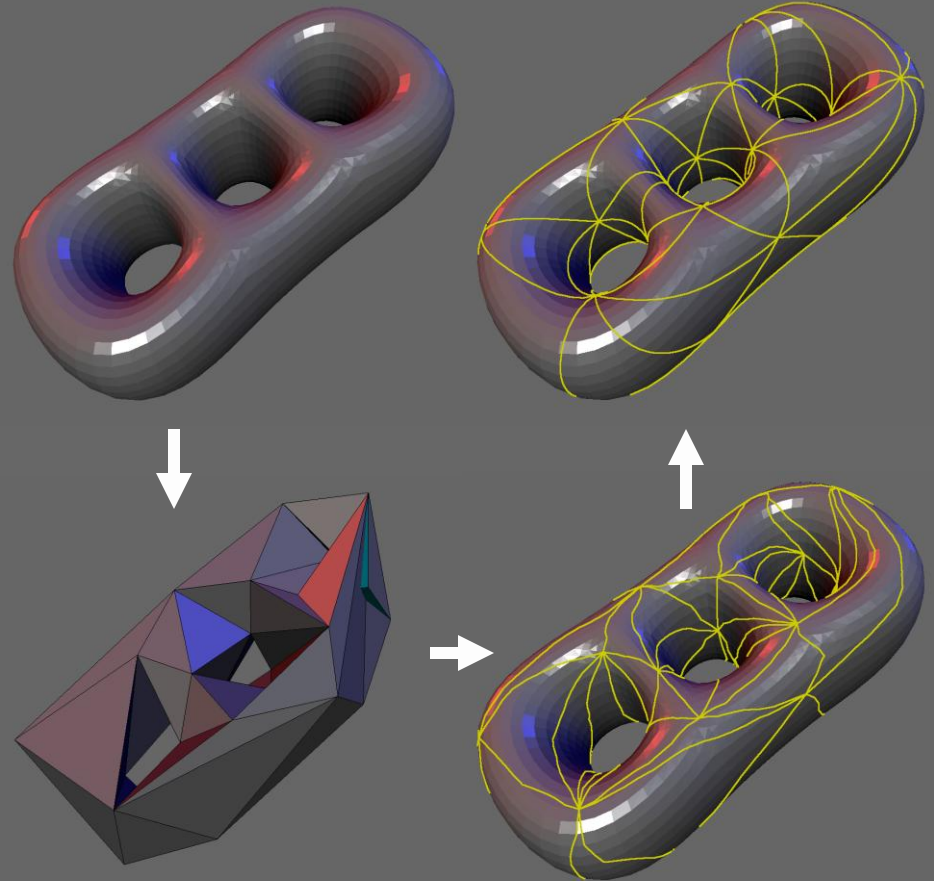
- simplification

Boundaries

- propagated

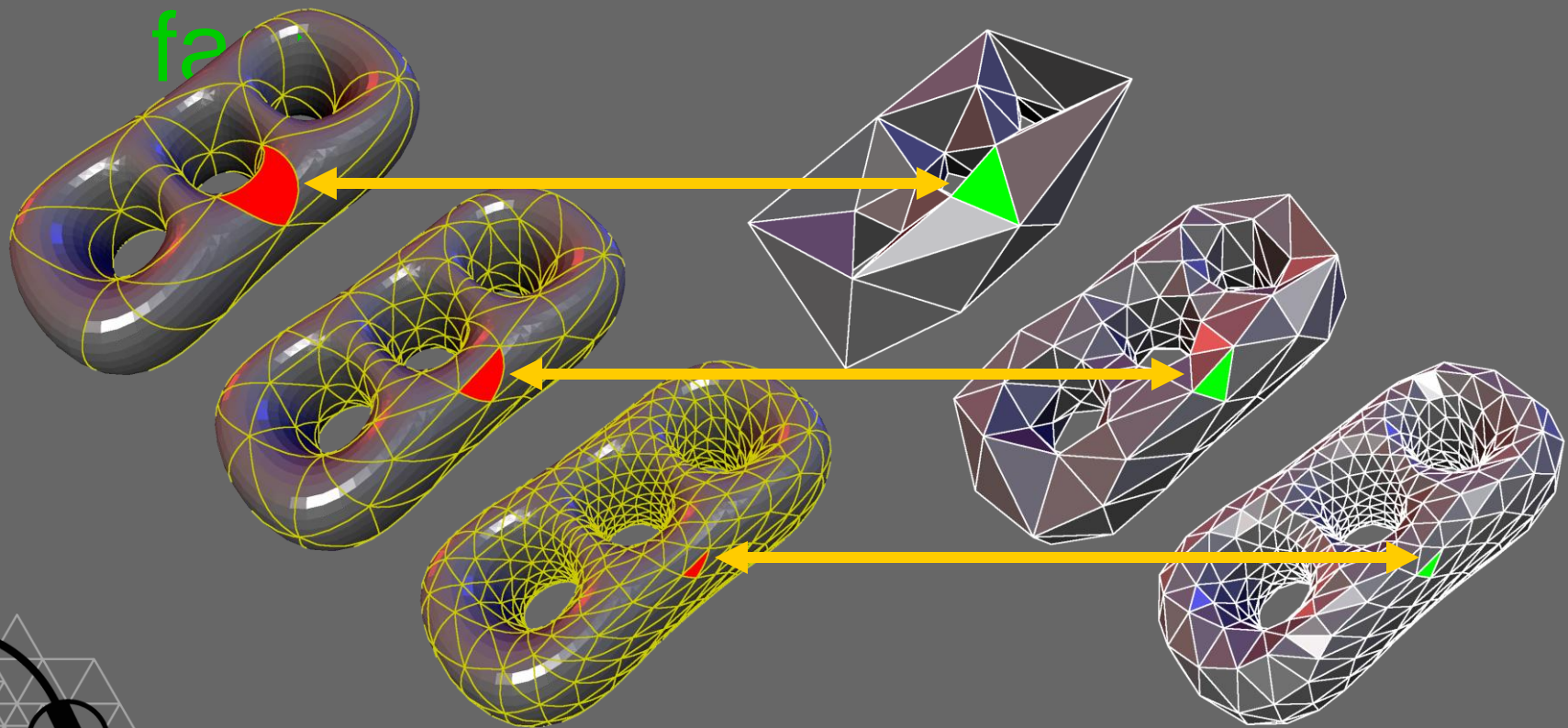
Global vertices

- relocated

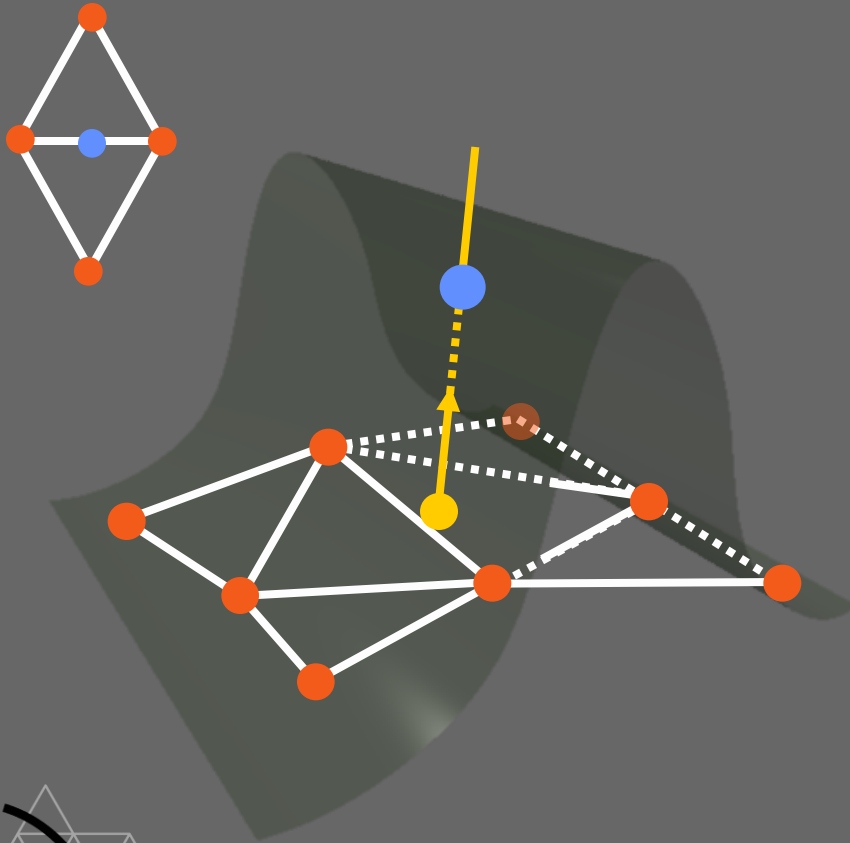


Remeshing Procedure

Correspondence: **patches** ↔



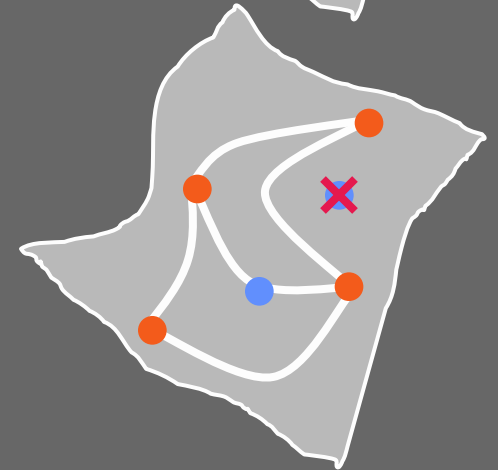
Piercing & Patches



Canonical:



Exception:

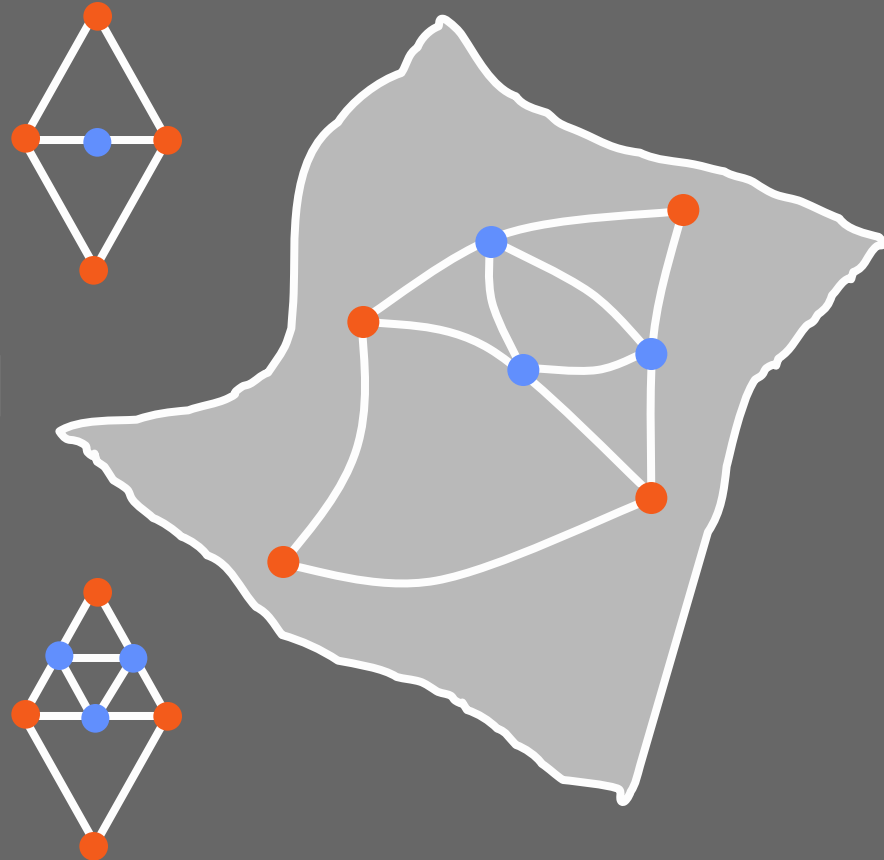


Maintenance

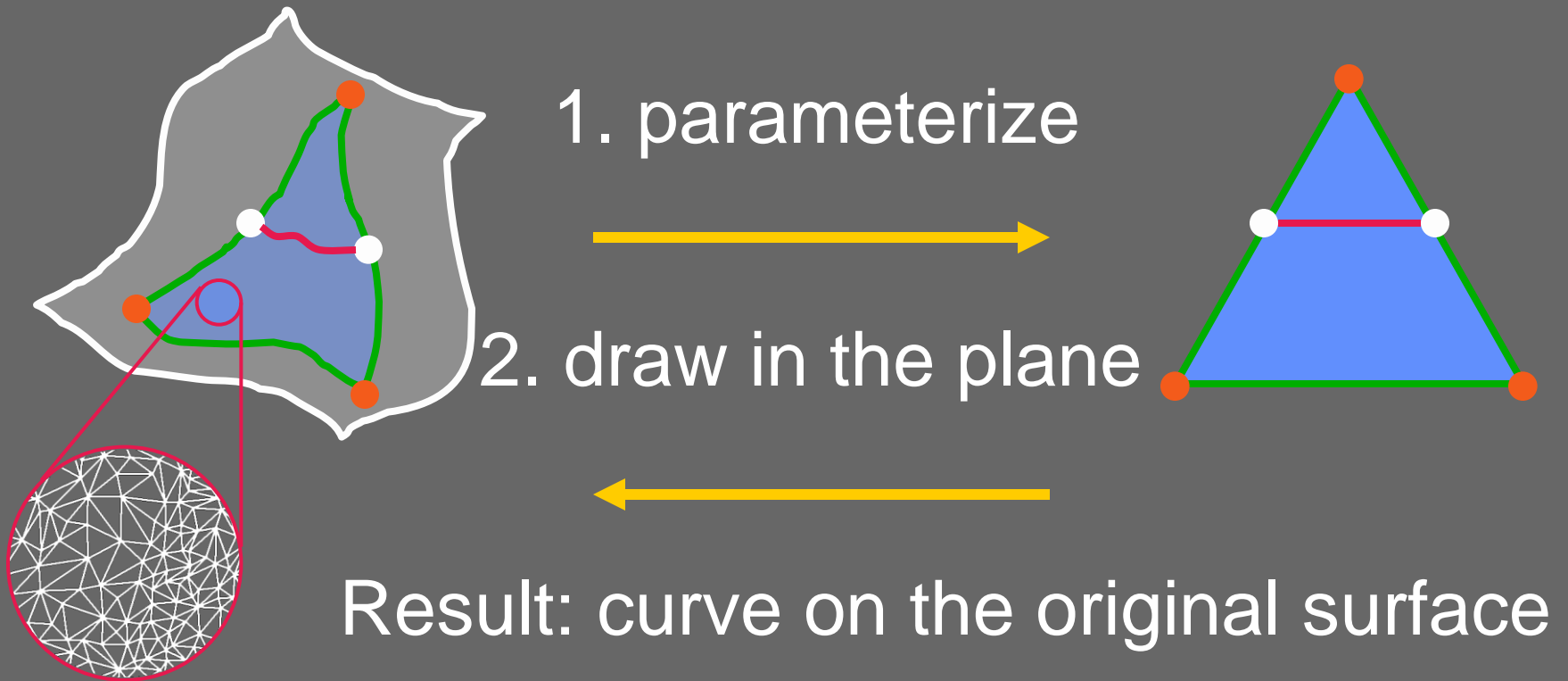
Operations

- new vertex
 - curve updated

- new edges
 - new curves



Drawing Curves

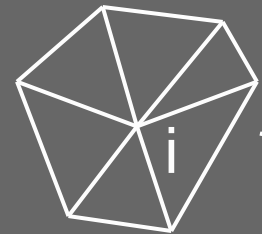


Parameterization

Floater '97

- linear system

$$\sum_j \alpha_{ij} u_j = u_i$$



- conjugate gradient solver
- good initial guess



Results

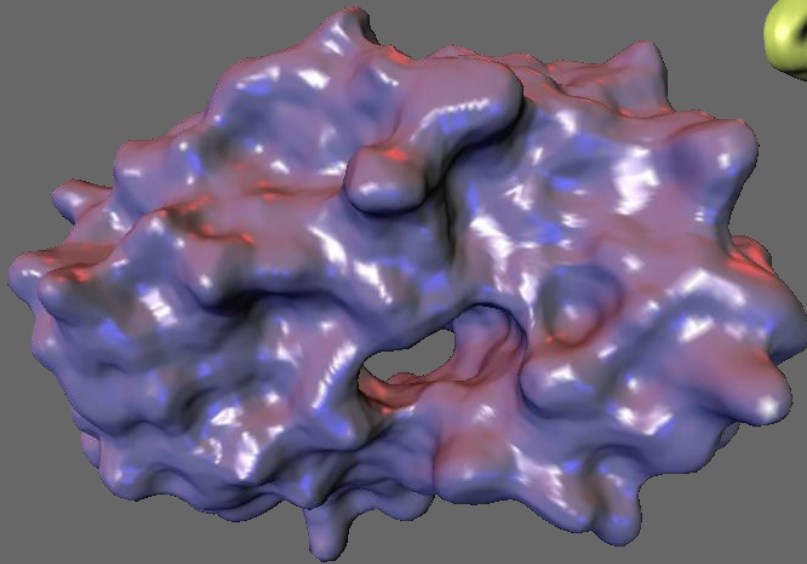


(mean-square) error = 0.0056%

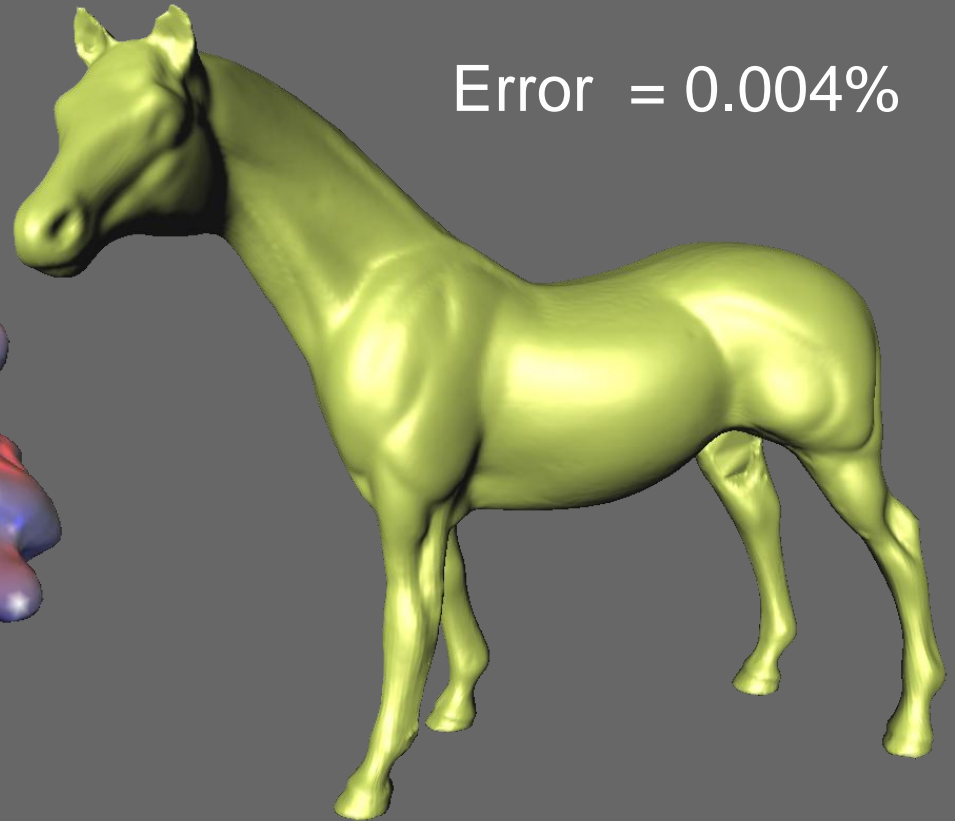


More Results

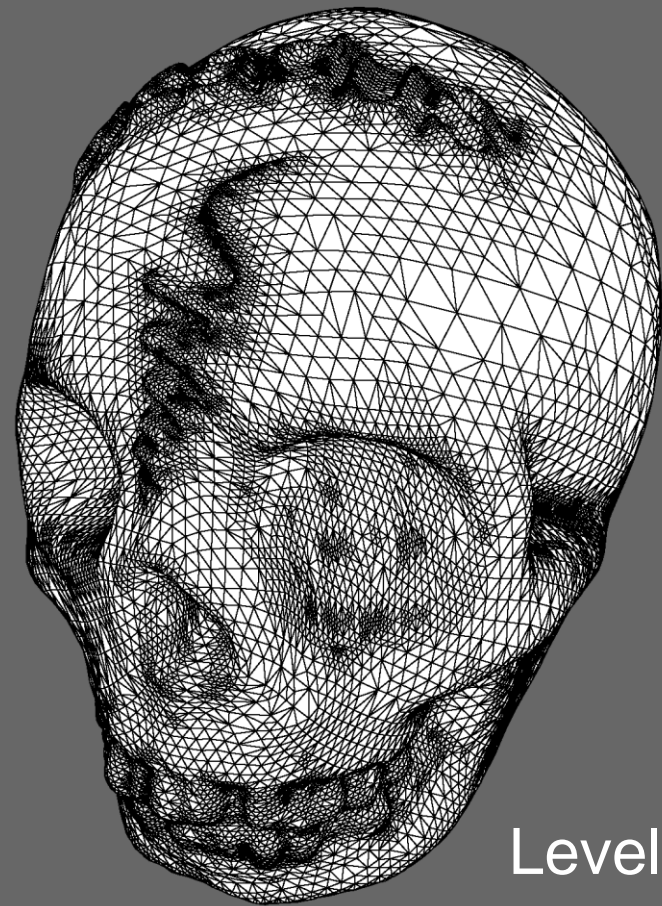
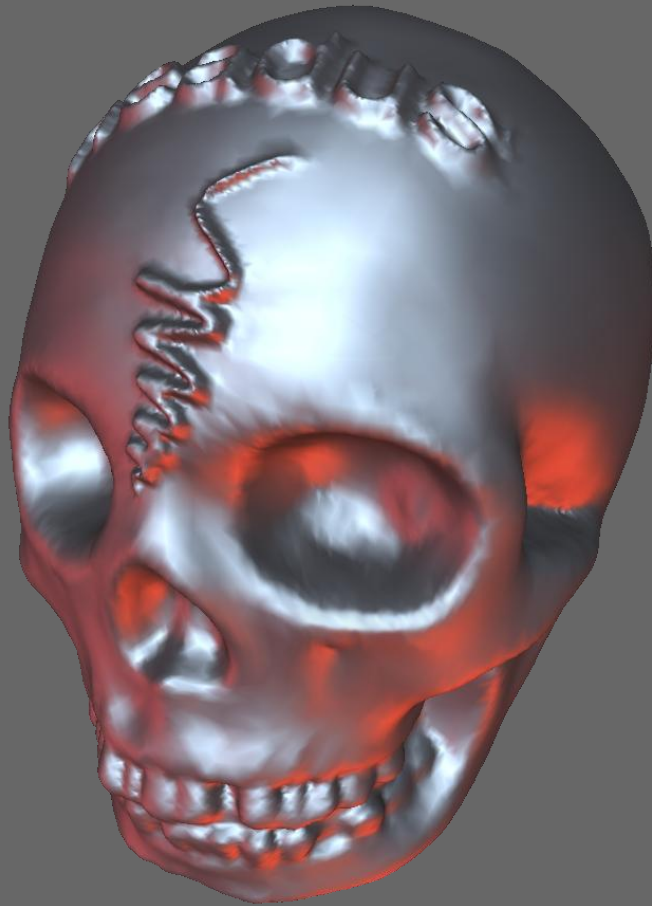
Error = 0.01%



Error = 0.004%



Adaptive Remeshing



Level 10



Table

model	size	not norma	error	time
Feline	50,00 0	789	.015 %	5 min
Torus3	6,000	421	.03%	3 min
Skull	25,00 0	817	.02%	3 min
Horse	60,00 0	644	.004 %	7 min



Conclusions

Normal meshes

- remeshing procedure

Future work

- approximating subdivision
 - Catmull-Clark, Loop
- applications of normal meshes
 - compression, processing



The End

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