meshgit

diffing and merging meshes for polygonal modeling

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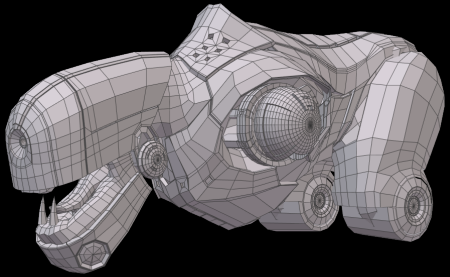
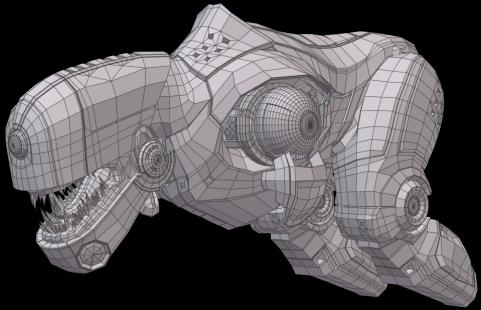
[†]dartmouth college, [*]sapienza university of rome



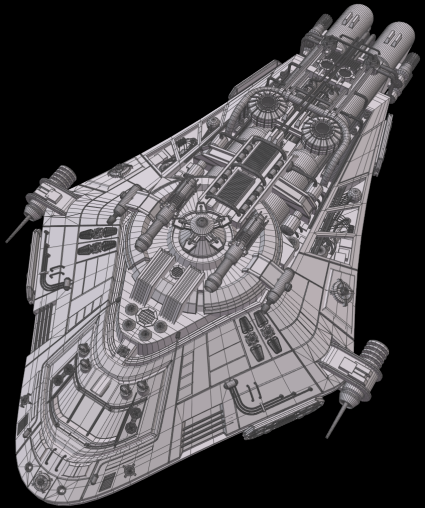
original



derivative

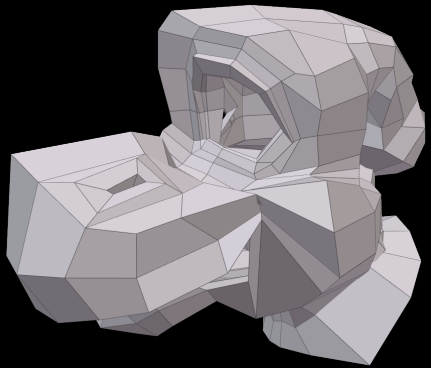
original

derivative

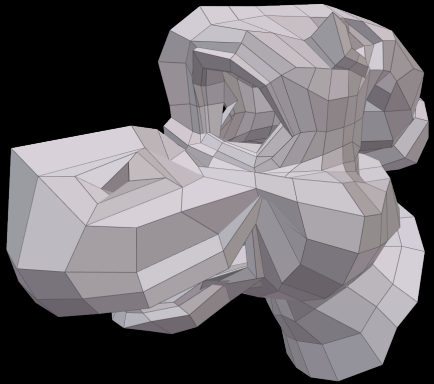


original

derivative

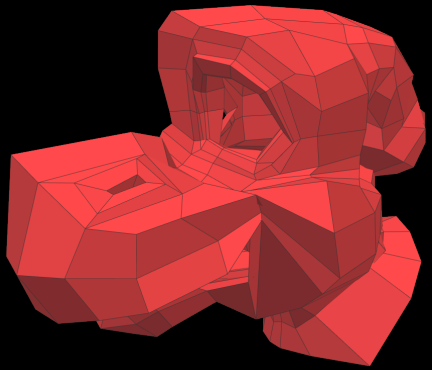


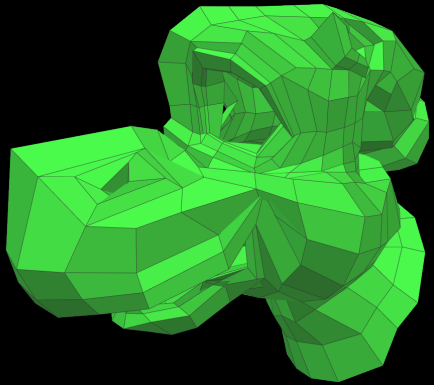
original



derivative

del, add

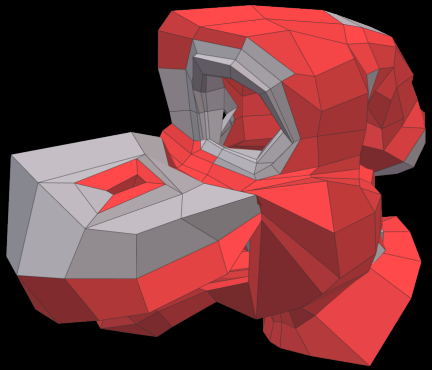




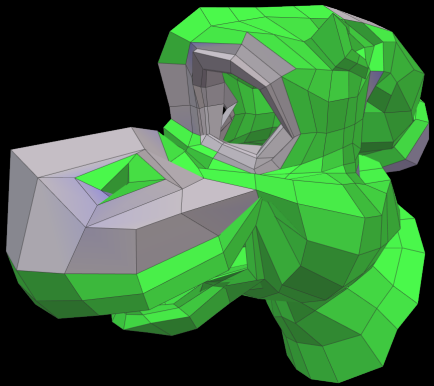
original

derivative

exact matching

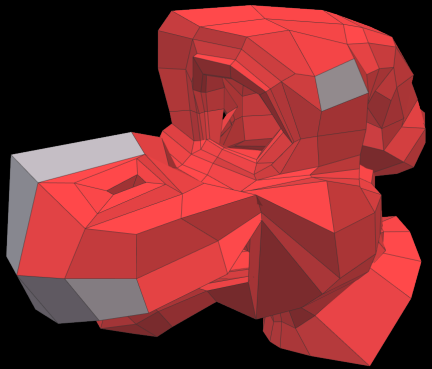


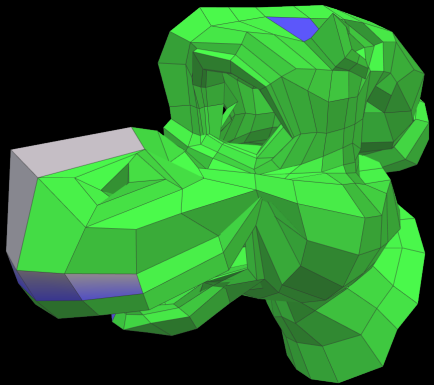
original



derivative

surface correspondence



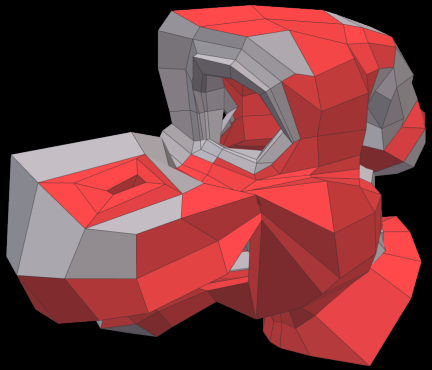


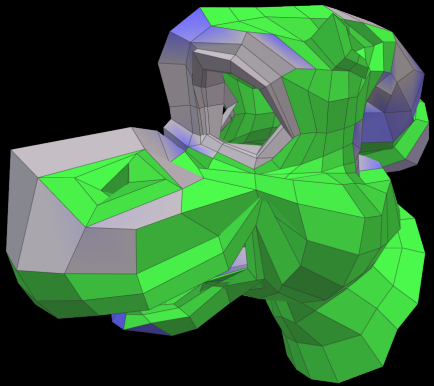
[kim et al. 2011]

original

derivative

graph matching



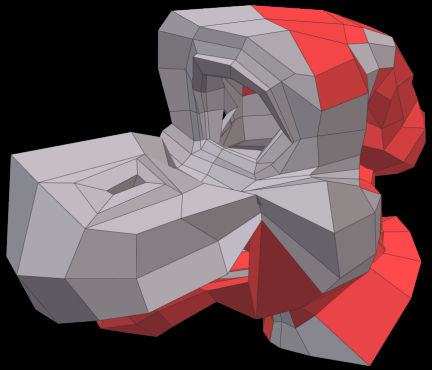


[cour et al. 2006]

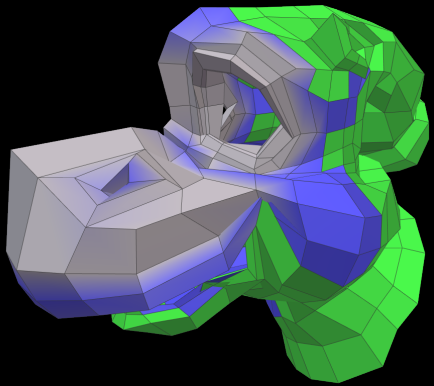
original

derivative

adjacency matching



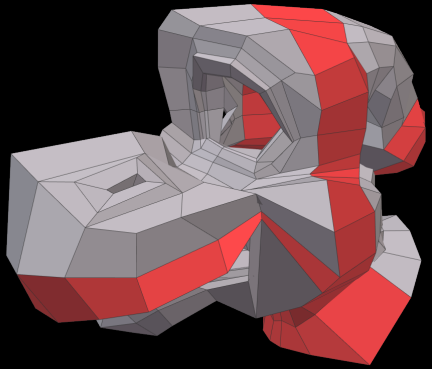
original



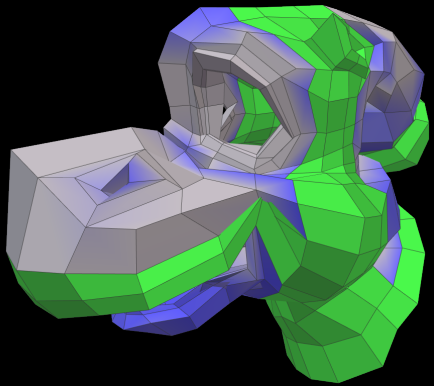
derivative

[eppstein et al. 2009]

meshgit



original



derivative

string edit distance / mesh edit distance

mesh edit distance

min cost of partially matching meshes

$$C(O) = C_u(O) + C_g(O) + C_a(O)$$

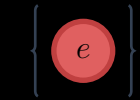
C_u : unmatched faces and verts

C_g : geometric changes

C_a : adjacency changes

O : partial matching of two meshes

$$C(O) = C_u(O) + C_g(O) + C_a(O)$$



original

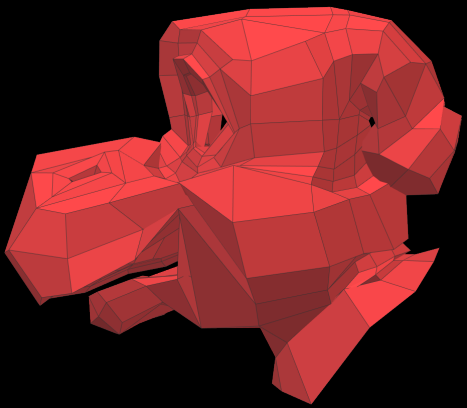
derivative

$$C(O) = C_u(O) + C_g(O) + C_a(O)$$

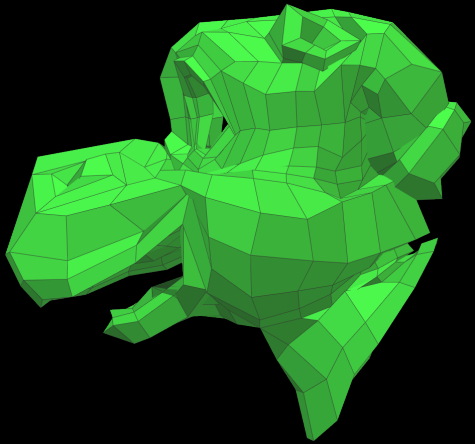
$$C_u(O) = N_u + N'_u$$

N : number of unmatched faces and verts

$$C(O) = C_u(O) + C_g(O) + C_a(O)$$

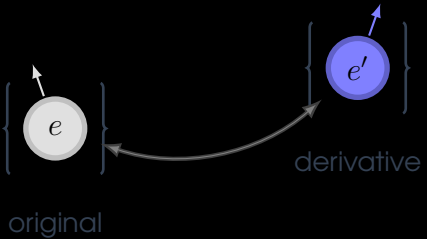


original



derivative

$$C(O) = C_u(O) + C_g(O) + C_a(O)$$



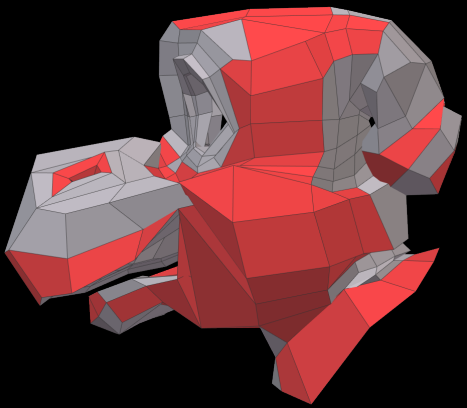
$$C(O) = C_u(O) + C_g(O) + C_a(O)$$

$$C_g(O) = \sum_{e \in E} \left[\frac{d(\mathbf{x}_e, \mathbf{x}_{e'})}{d(\mathbf{x}_e, \mathbf{x}_{e'}) + 1} + (1 - \mathbf{n}_e \cdot \mathbf{n}_{e'}) \right]$$

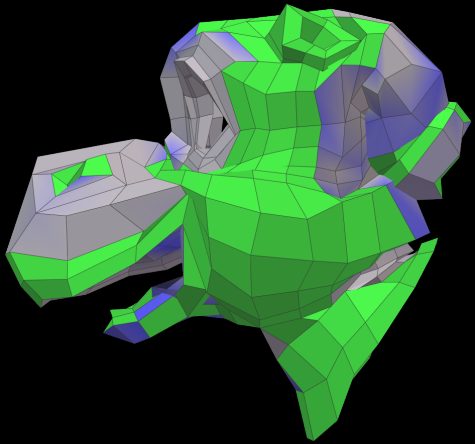
E : matched faces and verts

$\mathbf{x}$: position $\quad$ $\mathbf{n}$: normal $\quad$ $d(\mathbf{x}_e, \mathbf{x}_{e'}) = |\mathbf{x}_e - \mathbf{x}_{e'}|$

$$C(O) = C_u(O) + C_g(O) + C_a(O)$$

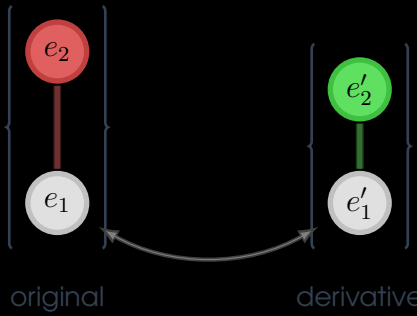


original

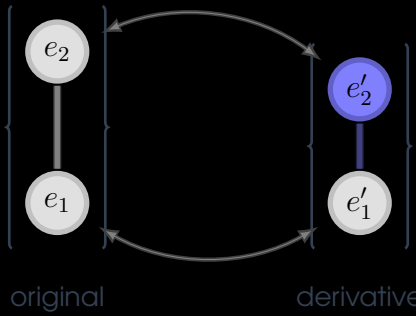


derivative

$$C(O) = C_u(O) + C_g(O) + C_a(O)$$



$$C(O) = C_u(O) + C_g(O) + C_a(O)$$



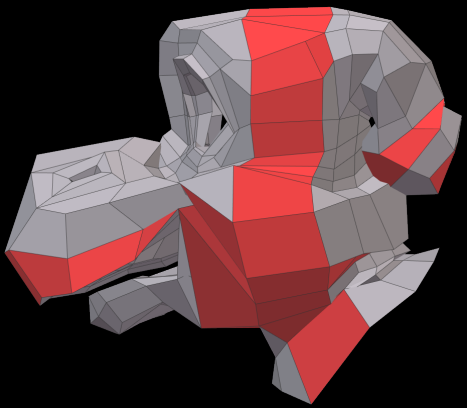
$$C(O) = C_u(O) + C_g(O) + C_a(O)$$

$$C_a(O) = \begin{cases} \displaystyle\sum_{(e_1,e_2)\in\{U,U'\}} \frac{1}{v(e_1)+v(e_2)} & + \\ + \displaystyle\sum_{(e_1,e_2)\in\{A,A'\}} \frac{w(e_1,e_2,e_1',e_2')}{v(e_1)+v(e_2)} \end{cases}$$

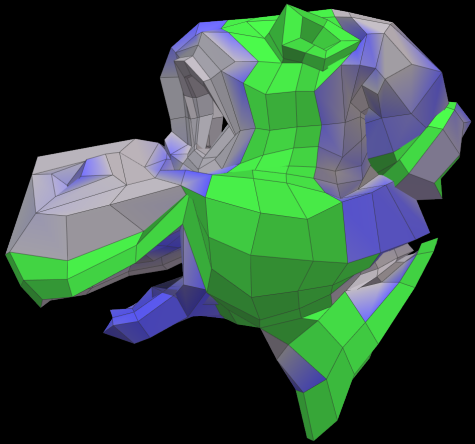
U, U' : unmatched adj pair $\quad$ A, A' : matched adj pair

$v(\cdot)$: valence $\quad$ $w(e_1,e_2,e_1',e_2') = \dfrac{|d(\mathbf{x}_{e_1},\mathbf{x}_{e_2}) - d(\mathbf{x}_{e_1'},\mathbf{x}_{e_2'})|}{d(\mathbf{x}_{e_1},\mathbf{x}_{e_2}) + d(\mathbf{x}_{e_1'},\mathbf{x}_{e_2'})}$

$$C(O) = C_u(O) + C_g(O) + C_a(O)$$



original



derivative

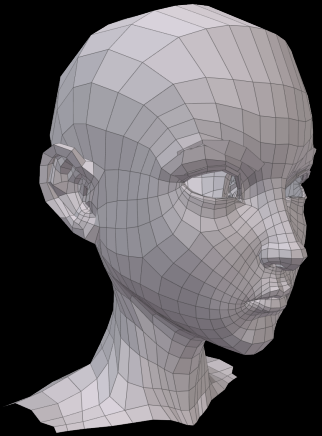
min $C(O)$ / max common subgraph isomorphism

NP-Hard

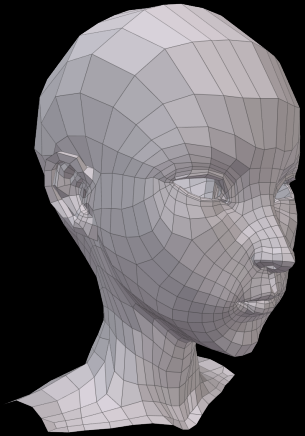
iterative greedy algorithm

feasibly approximate med

1. init 2. greedy 3. backtrack 4. repeat 2,3

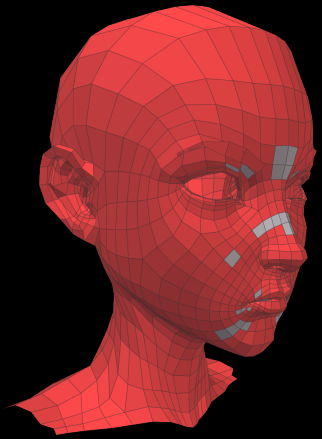


original

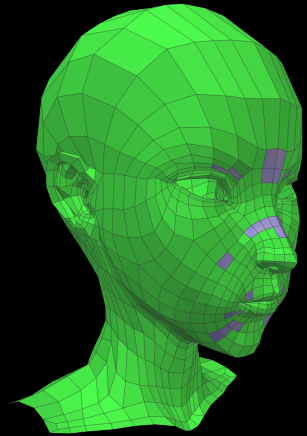


derivative

1. init 2. greedy 3. backtrack 4. repeat 2,3

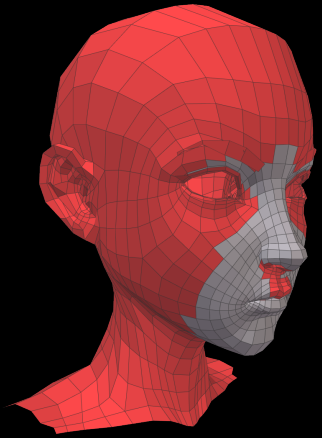


original



derivative

1. init 2. greedy 3. backtrack 4. repeat 2,3



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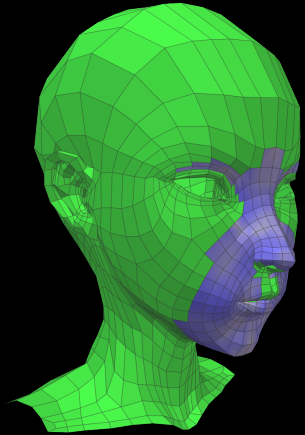

derivative

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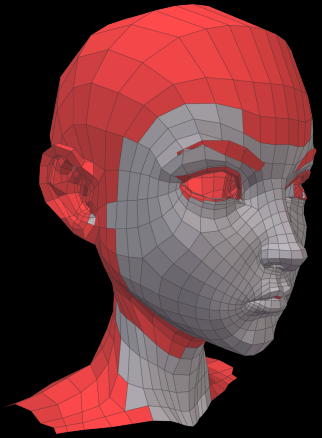

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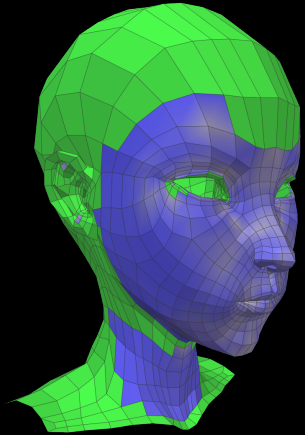
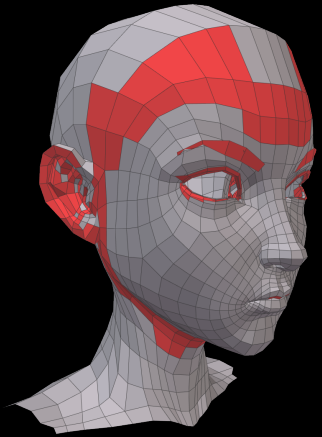
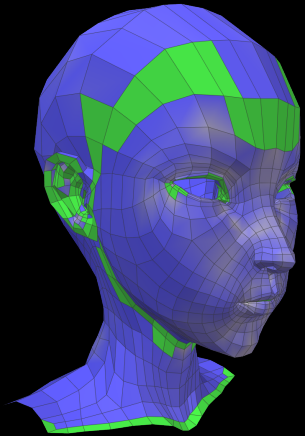


derivative

1. init 2. greedy 3. backtrack 4. repeat 2,3

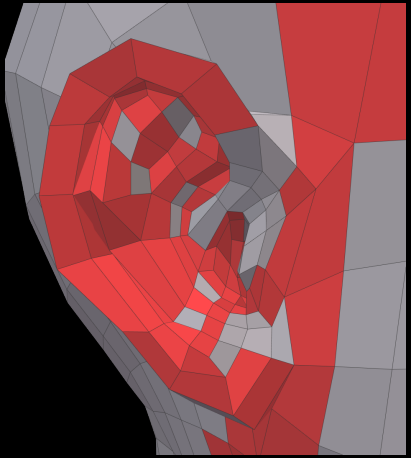


original

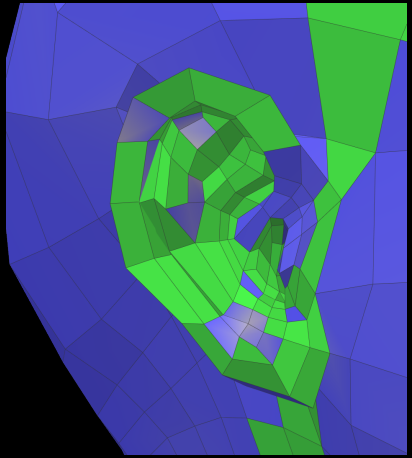


derivative

1. init 2. greedy 3. backtrack 4. repeat 2,3



original



derivative

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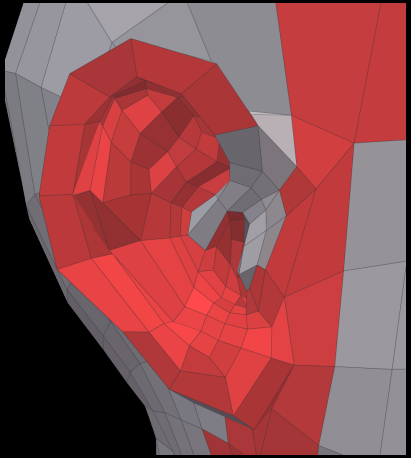
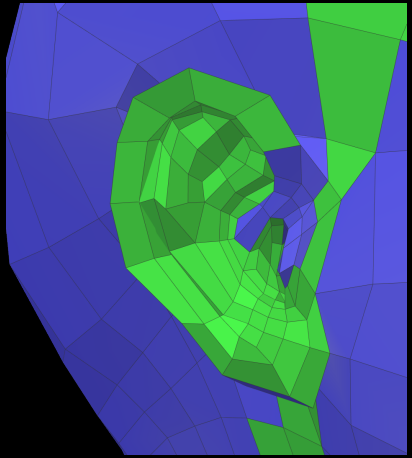


original



derivative

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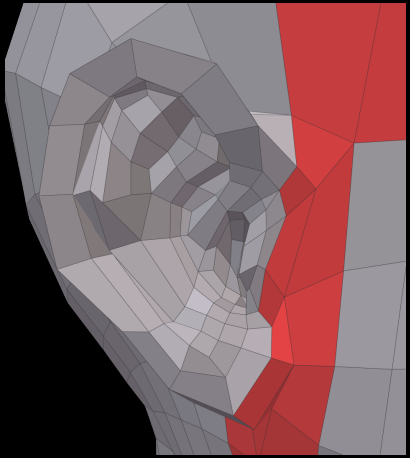
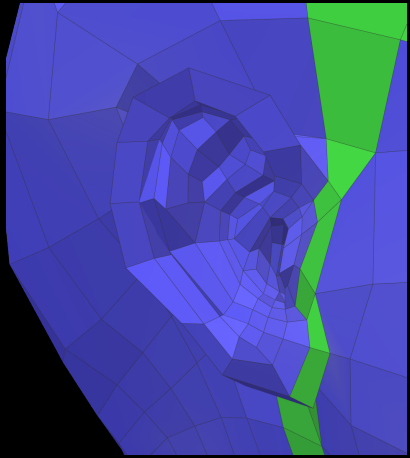


original



derivative

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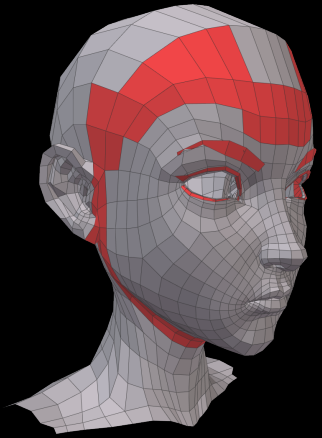
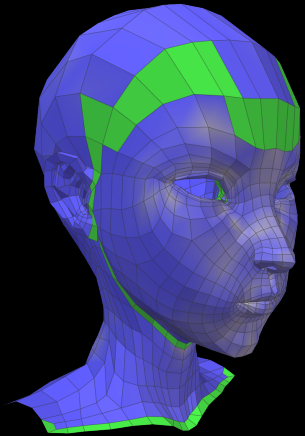


original



derivative

mesh edit operations

turn one mesh into another

delete	:	unmatched geometry in original
add	:	unmatched geometry in derivative
transform	:	matched vertices with geometric cost

2-way diff

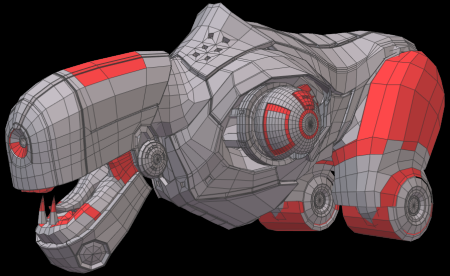
visualize edits from original to derivative

deleted faces colored red

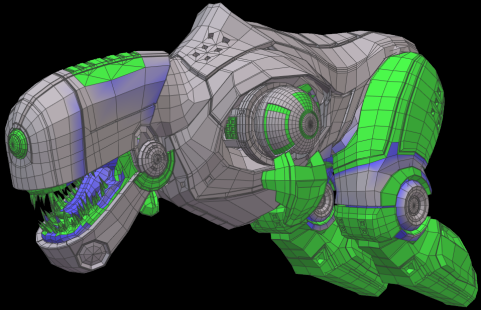
added faces colored green

transformed vertices colored blue

unmoved vertices colored gray

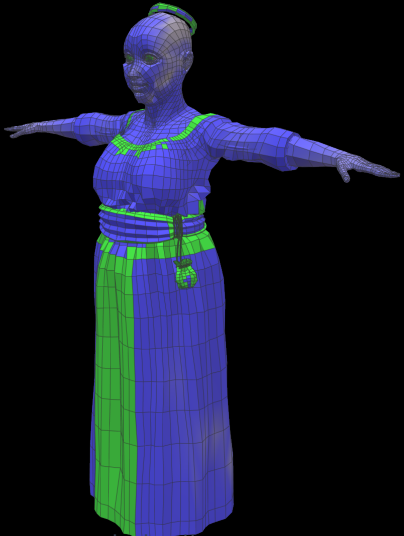


original

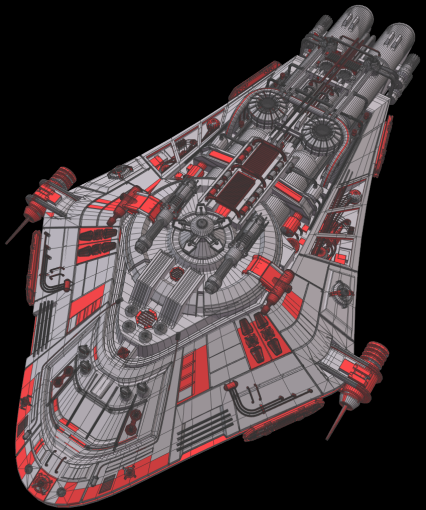


derivative

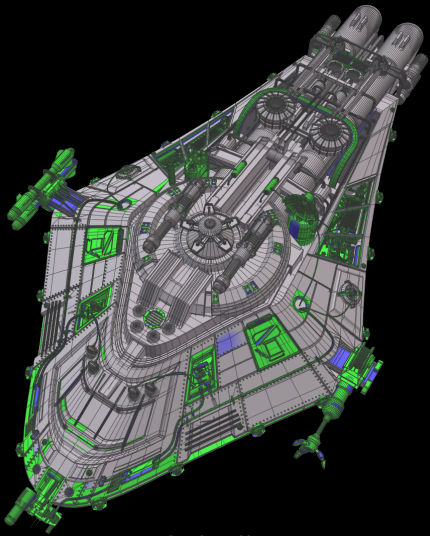
original



derivative



original



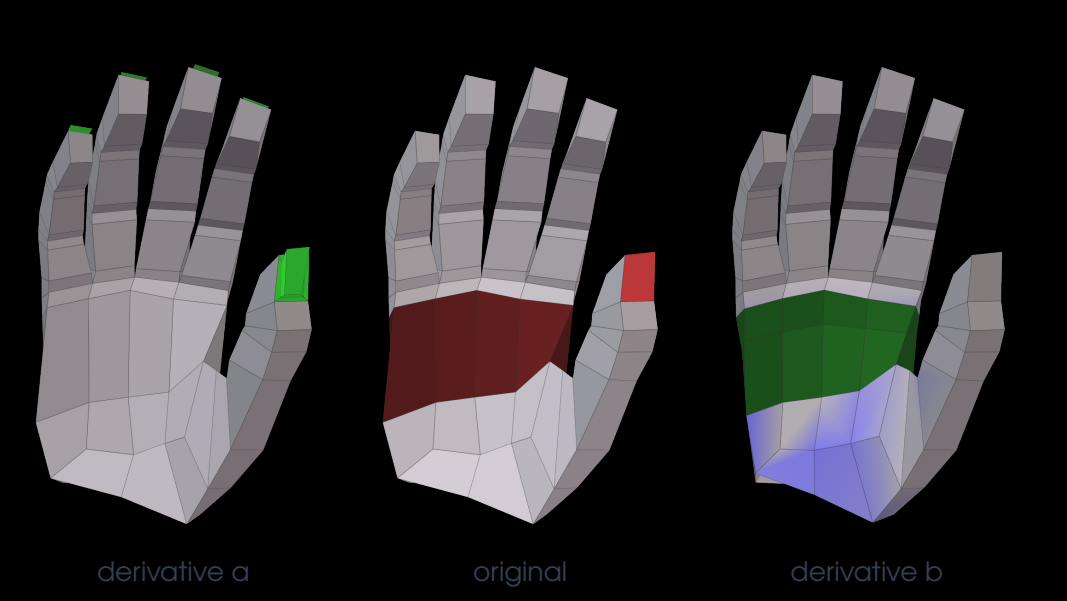
derivative

3-way diff

visualize edits from original to two independent derivatives

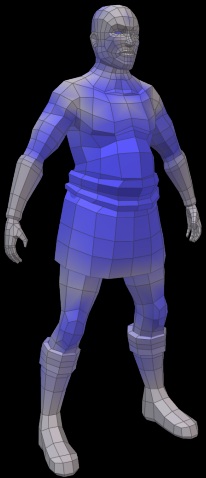
brightness of add/del face indicates derivative

overlapping deleted faces colored yellow

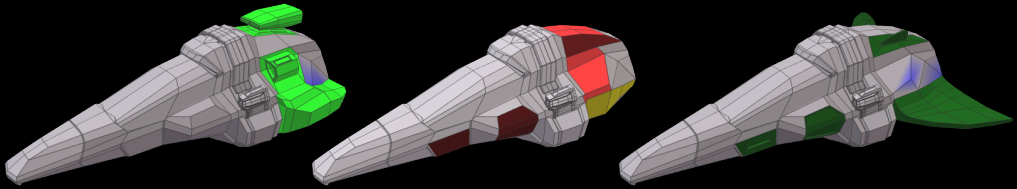

derivative a
original
derivative b

derivative a

original



derivative b

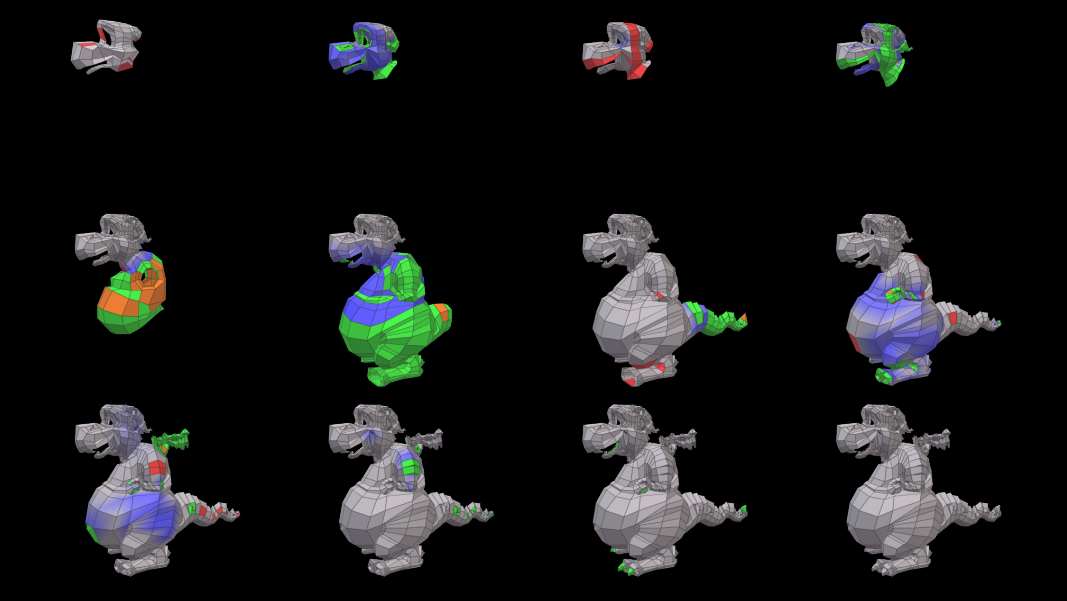


derivative a original derivative b

diff sequence

visualize edits along sequence

added then deleted faces colored orange

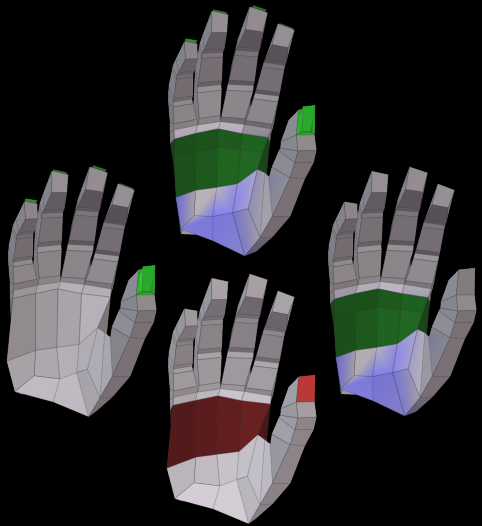


mesh edit merge

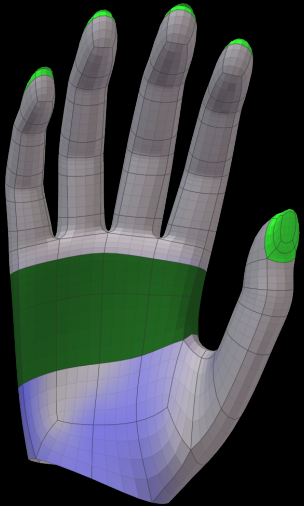
combining independent edits

merge is automatic if edits do not overlap on original

adjacency is maintained; subdivision surfaces

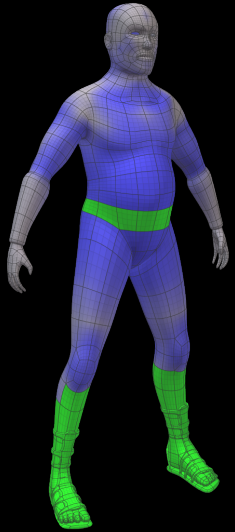


3-way + merge

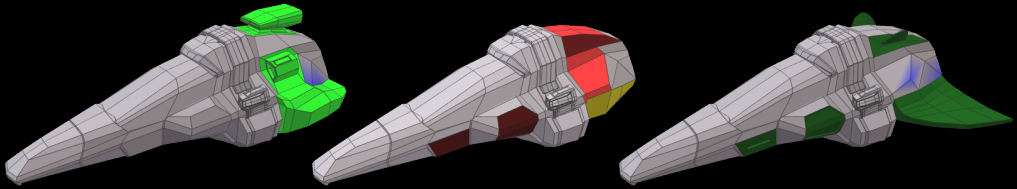


merge subd

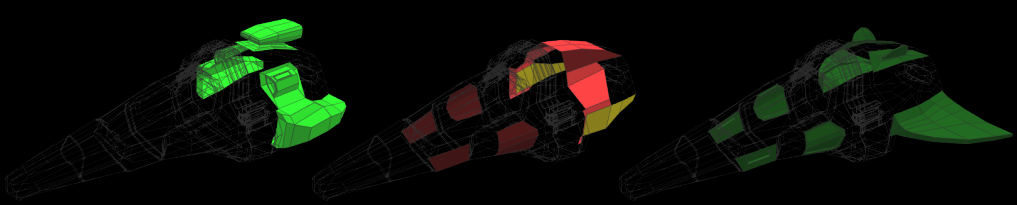
3-way + merge



merge subd



derivative a original derivative b



derivative a original derivative b

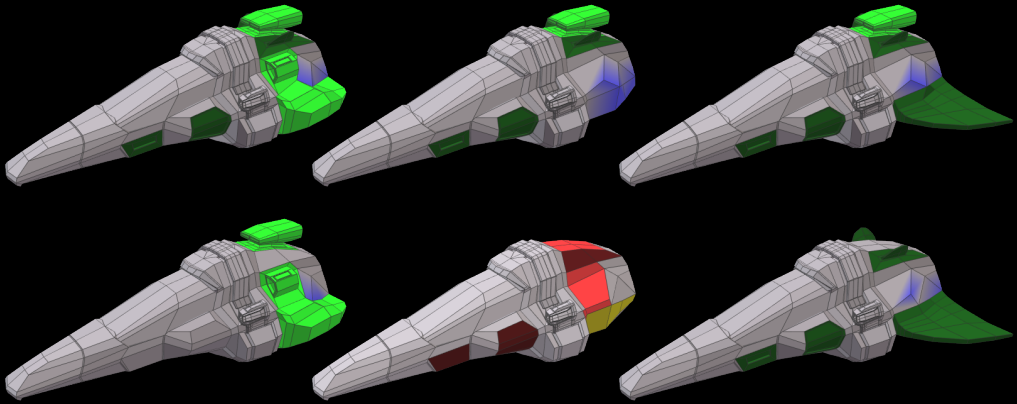
edit partitioning

reduce granularity of conflicts

choose a

neither

choose b



derivative a

original

derivative b

future work

single object	/	hierarchical, component attributes
low-level ops	/	high-level operations
diff, merge	/	spatial undo, feature permutation, etc.

summary

mesh edit distance	:	match polygonal meshes
iterative greedy algorithm	:	feasibly approx med
mesh edit operations	:	visualize, apply changes
edit partitioning	:	reduce granularity of conflicts

acknowledgements

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goralczyk grassard
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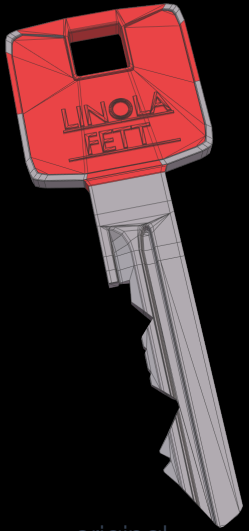
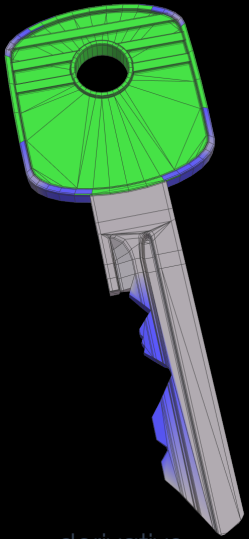
thomas vazquez
williamson

intel nsf sloan foundation

thank you!



original



derivative

timing

chairs	3951	4.7s
creature	17433	14.5s
dragon	96616	307.9s
durano	3722	1.5s
hand	209	0.1s
keys	1854	6.7s
shaolin	2158	2.4s
sintel	1810	2.7s
spaceship	2173	0.9s
shuttle	193970	585.3s
woman	13984	33.7s