iCutter: A Direct Cut Out Tool for 3D Shapes

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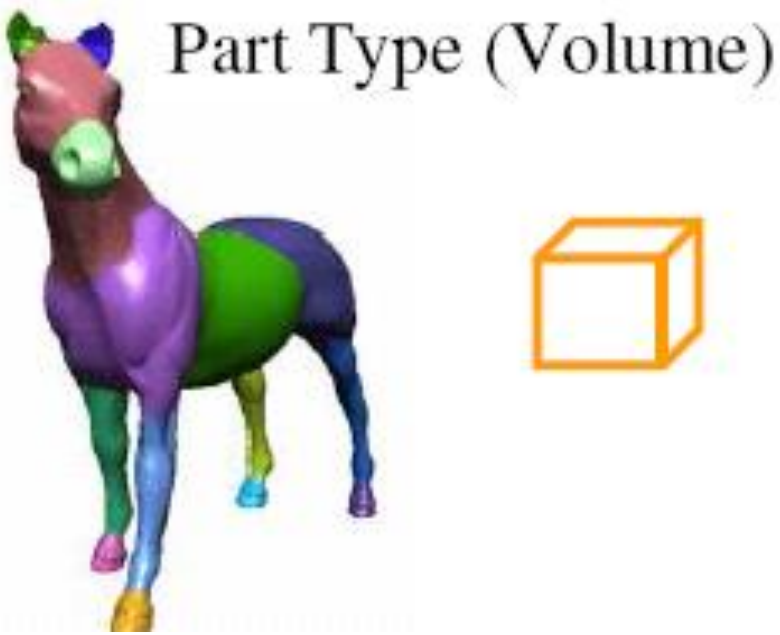
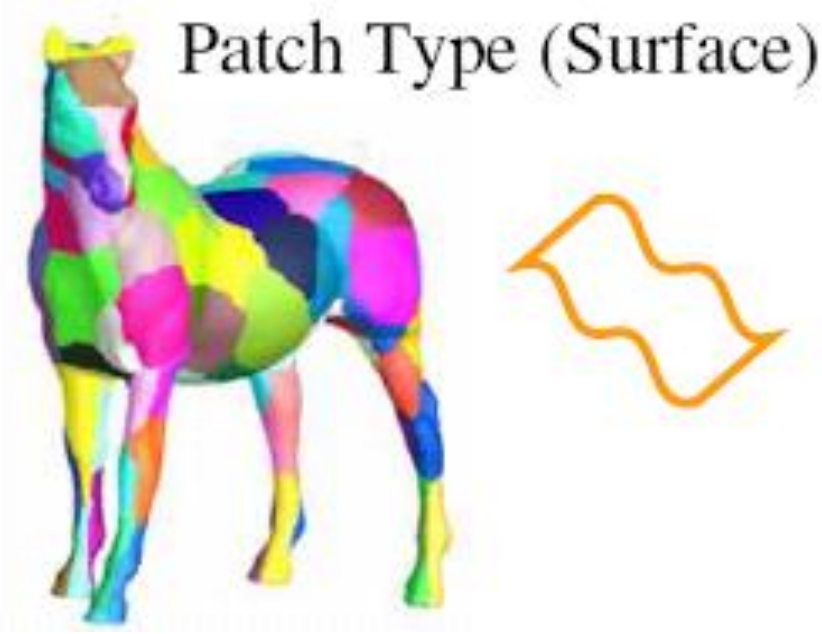
Outline

- Problem statement
- User interface
- Segmentation method
- Experimental results
- Conclusion

Surface Segmentation

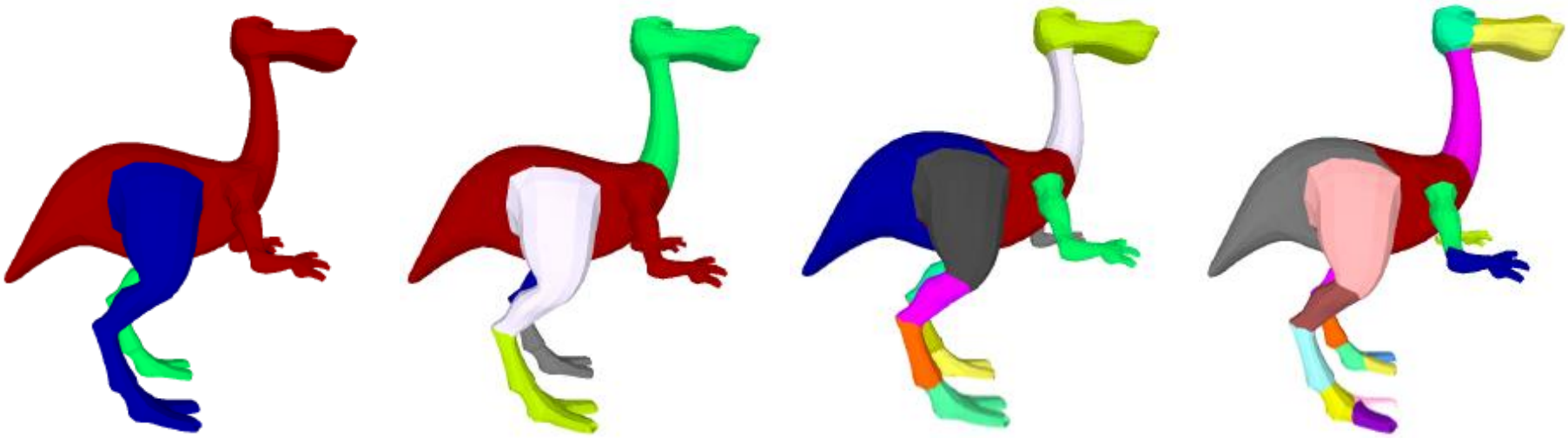
- How does a shape consist of the subparts?





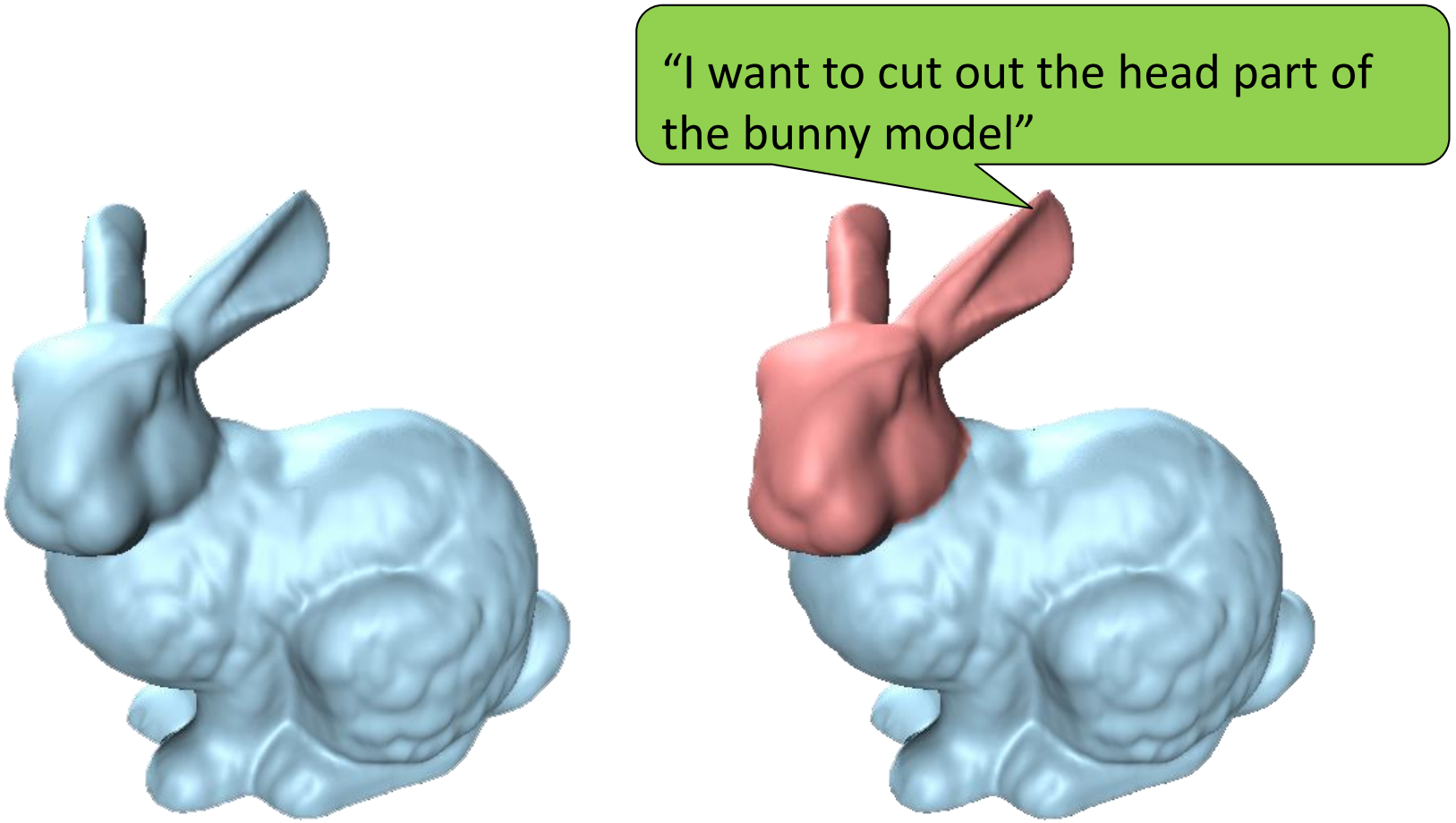
Segmentation of Meaningful Parts

- Automatic
- Interactive
  - User intension
  - Application dependent



User Interfaces

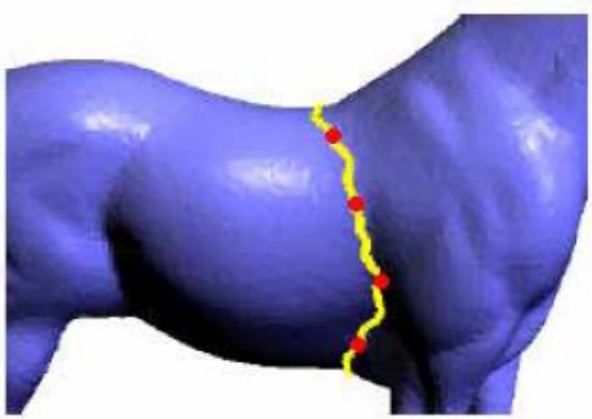
- How can users to express their intension?



User Interfaces

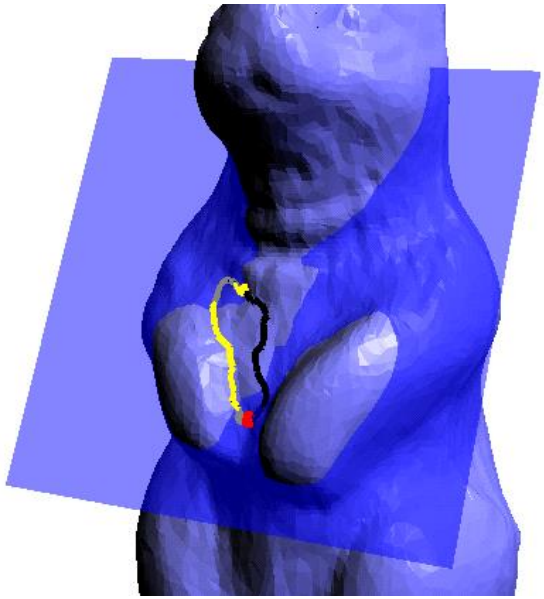
- User interfaces should be
  - Easy to use
  - Intuitive

Tedious



Specify vertices on surface

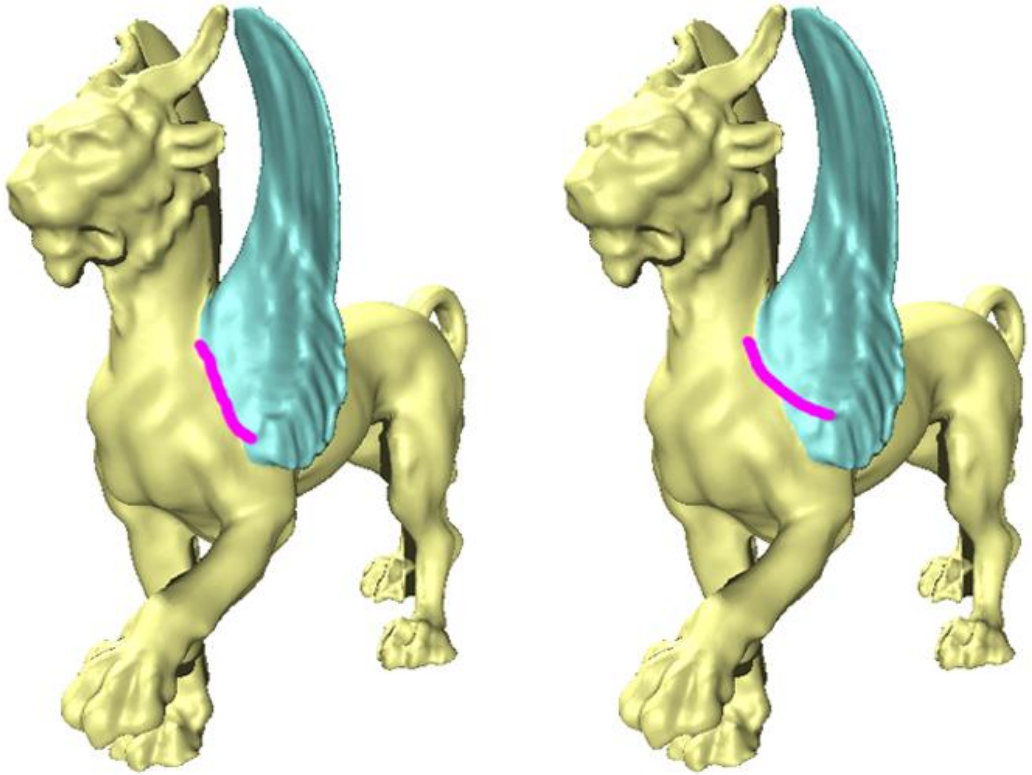
Non-Intuitive



Specify cutting plane

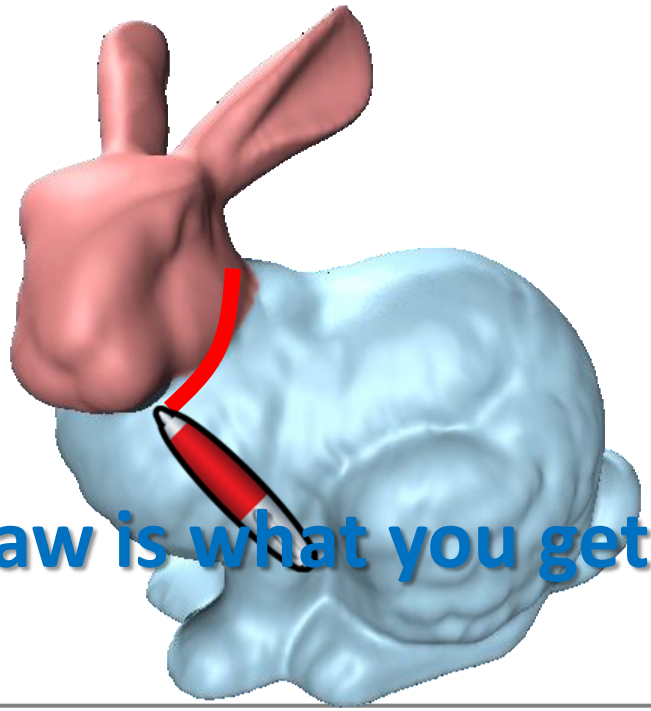
iCutter: Intelligent Cutter

- The user does not care much about how to draw the sketches



Sketching user interfaces

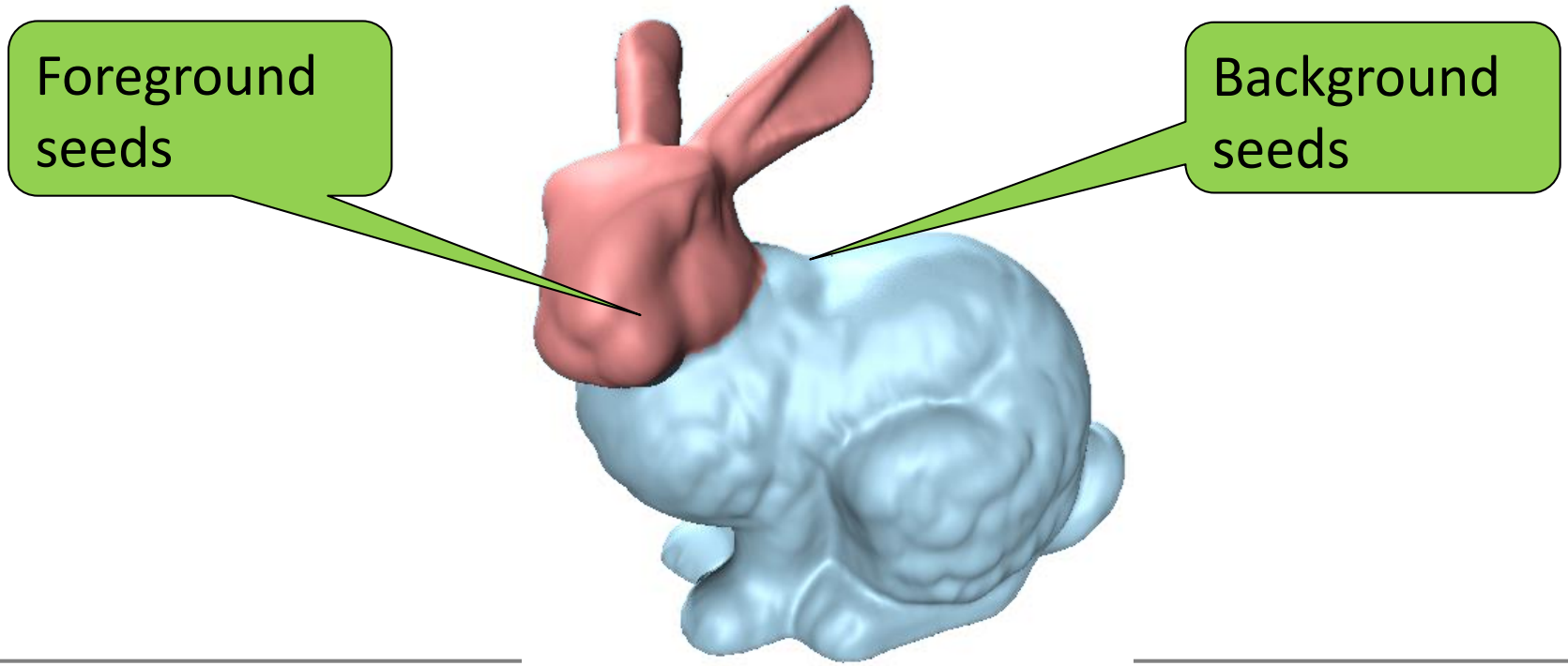
I want to cut out the head part from the bunny model…



What you draw is what you get!

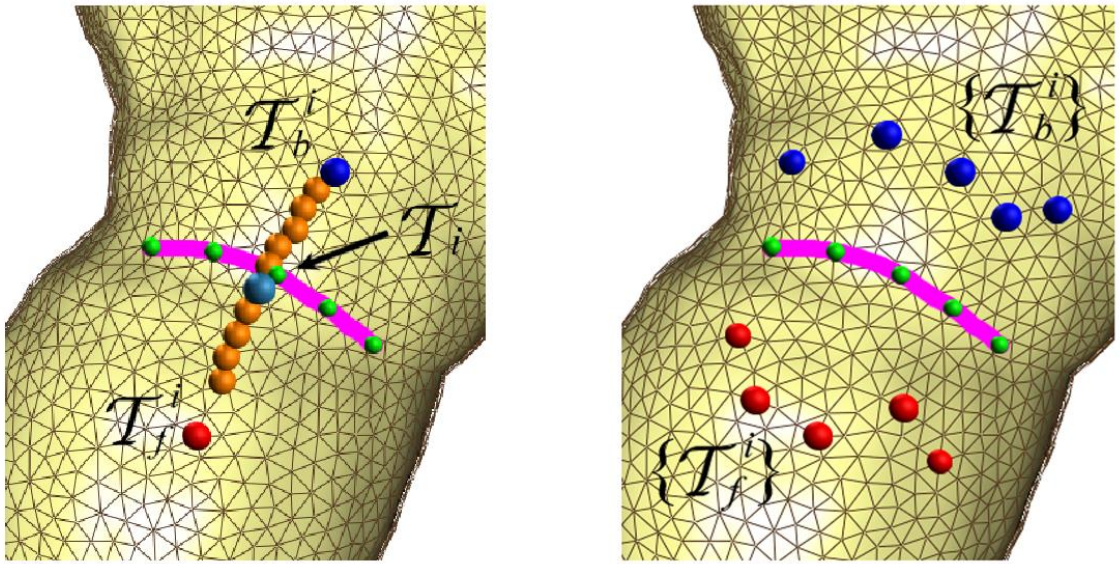
Basic idea

- Sample the foreground and background seeds along the input stroke
- Compute the cut based on these initial seeds



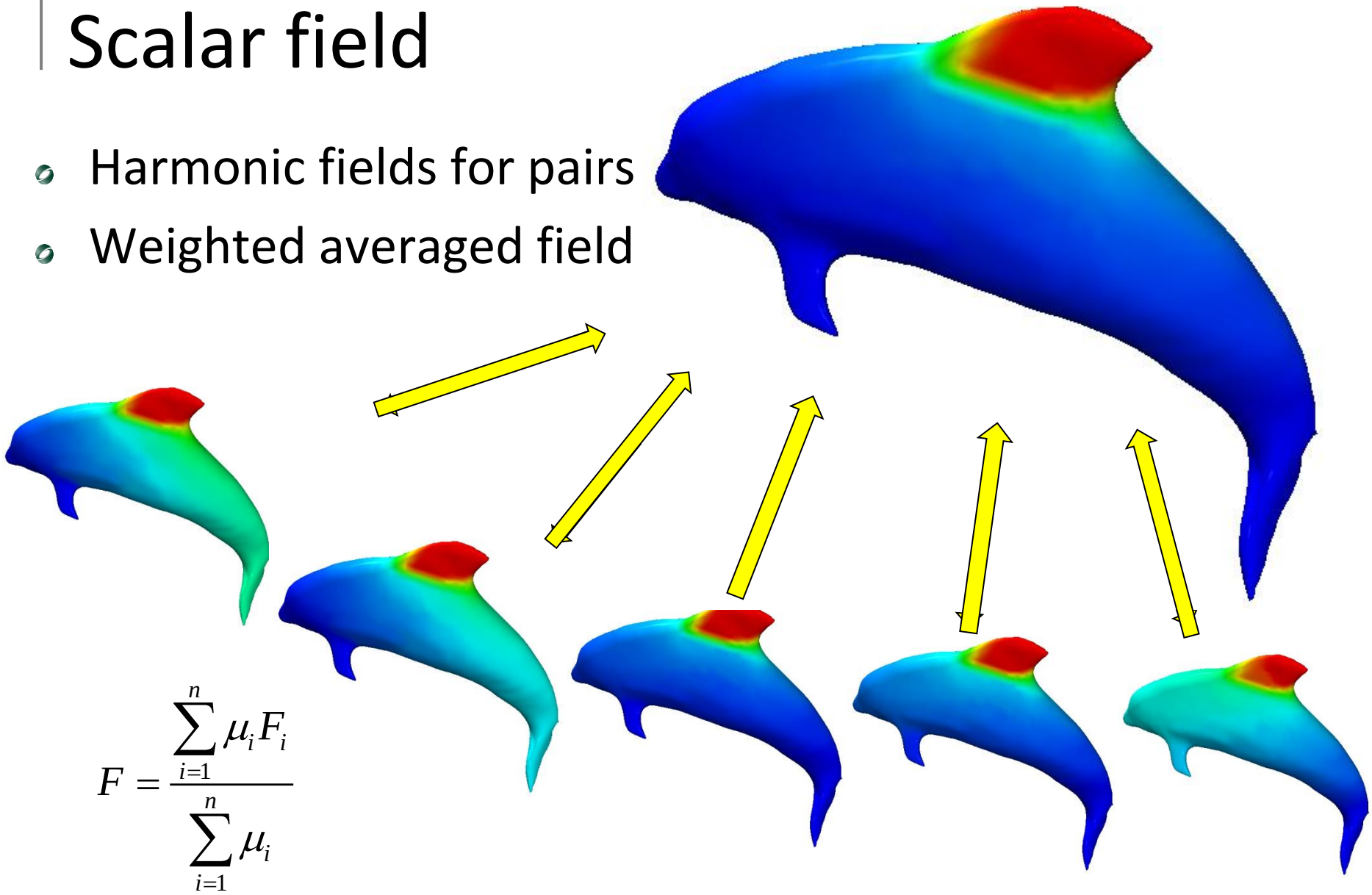
Adaptive sampling

- Stroke sampling
- Feature points selection
- Foreground/background candidate



Scalar field

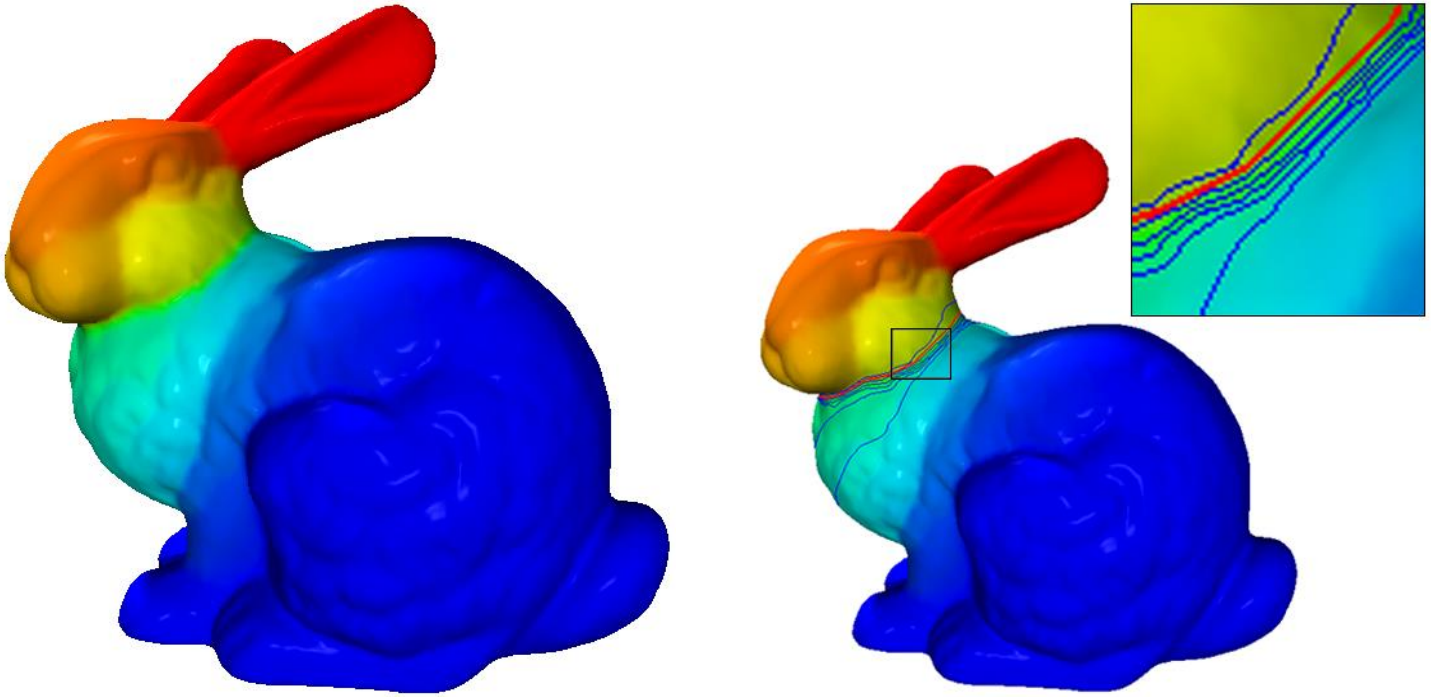
- Harmonic fields for pairs
- Weighted averaged field



$$F = \frac{\sum_{i=1}^{n} \mu_i F_i}{\sum_{i=1}^{n} \mu_i}$$

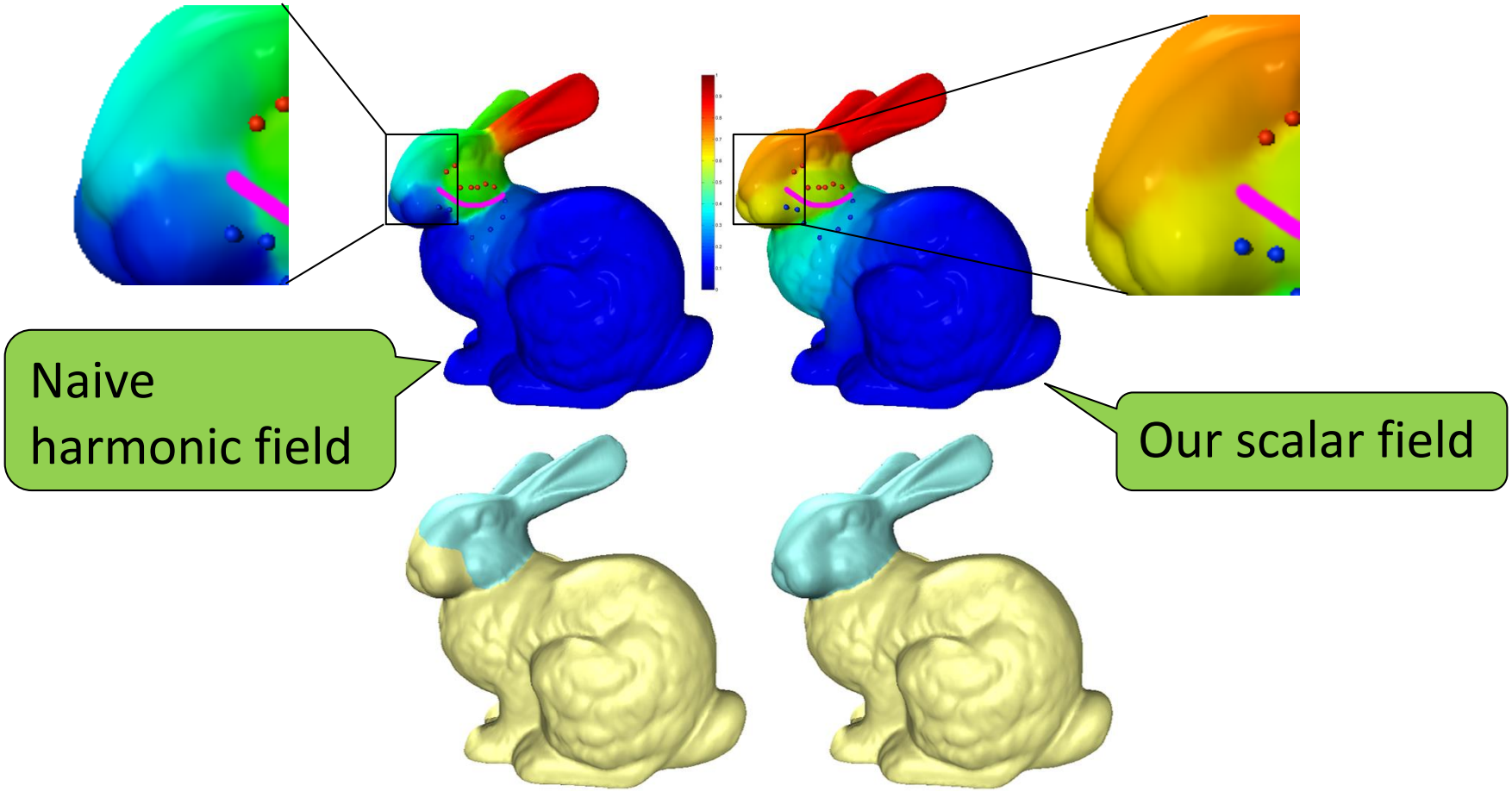
Cutting boundary

- Isoline selection
  - Centerness
  - Concaveness



Comparison of scalar field

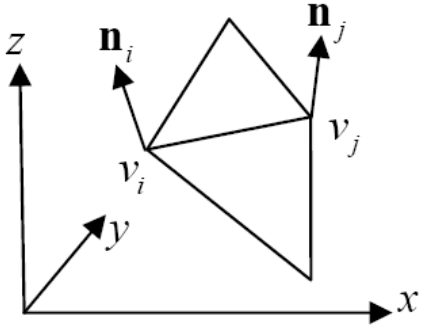
- Comparison between the naive harmonic field and our scalar field



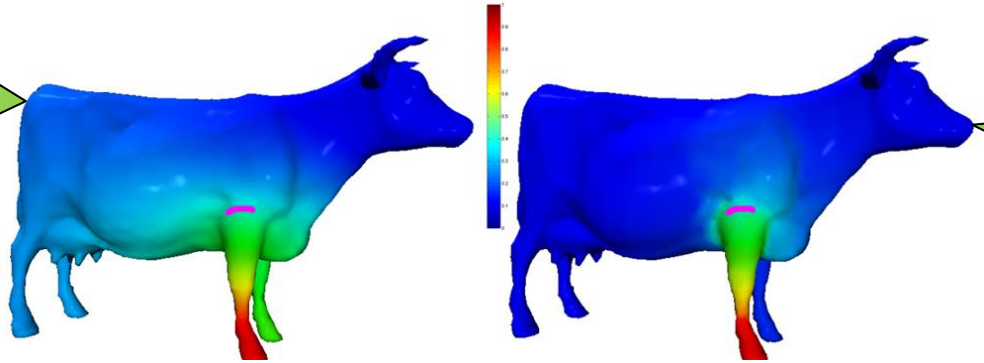
Geometry aware harmonic field

$$\Delta u_i = \sum_{j \in N_i} w_{ij}(u_i - u_j)$$

$$w_{ij} = \gamma(1 + \frac{\alpha_{ij}}{avg(\alpha_{ii})})^{-1}$$



Cotangent weight



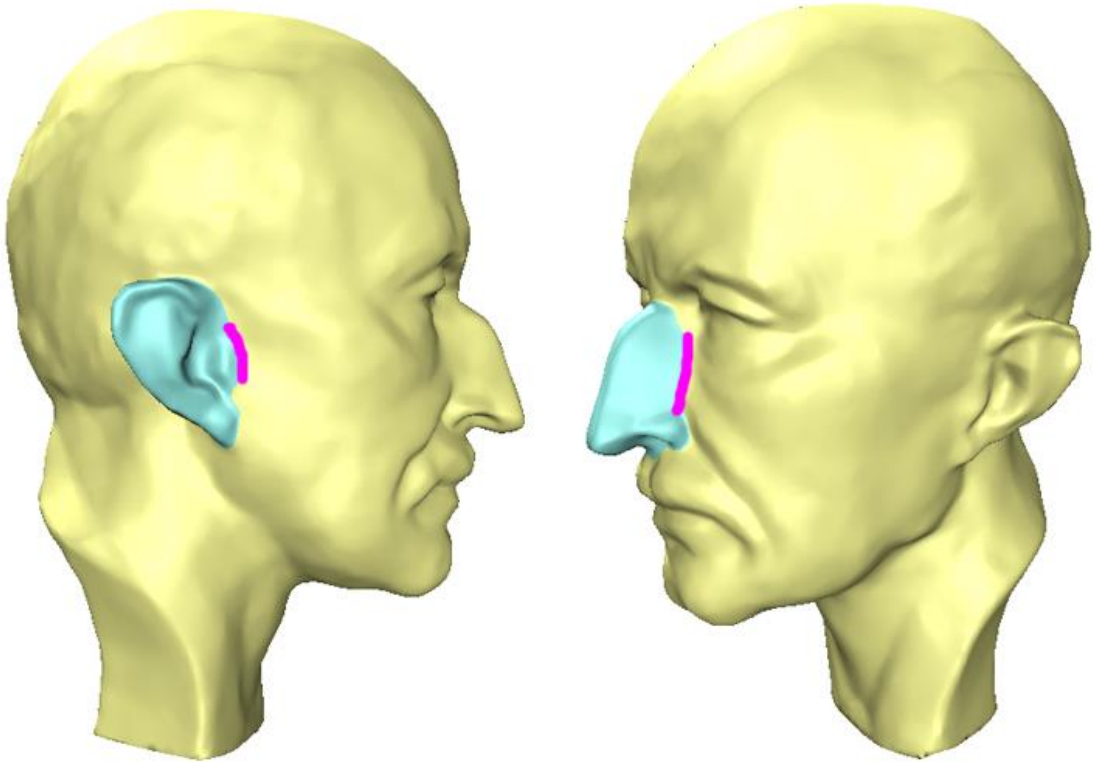
Our weight

Experimental results

- Intensive to input strokes, noise, pose

Experimental results

- Cut out local parts



Experimental results

- Multiple strokes

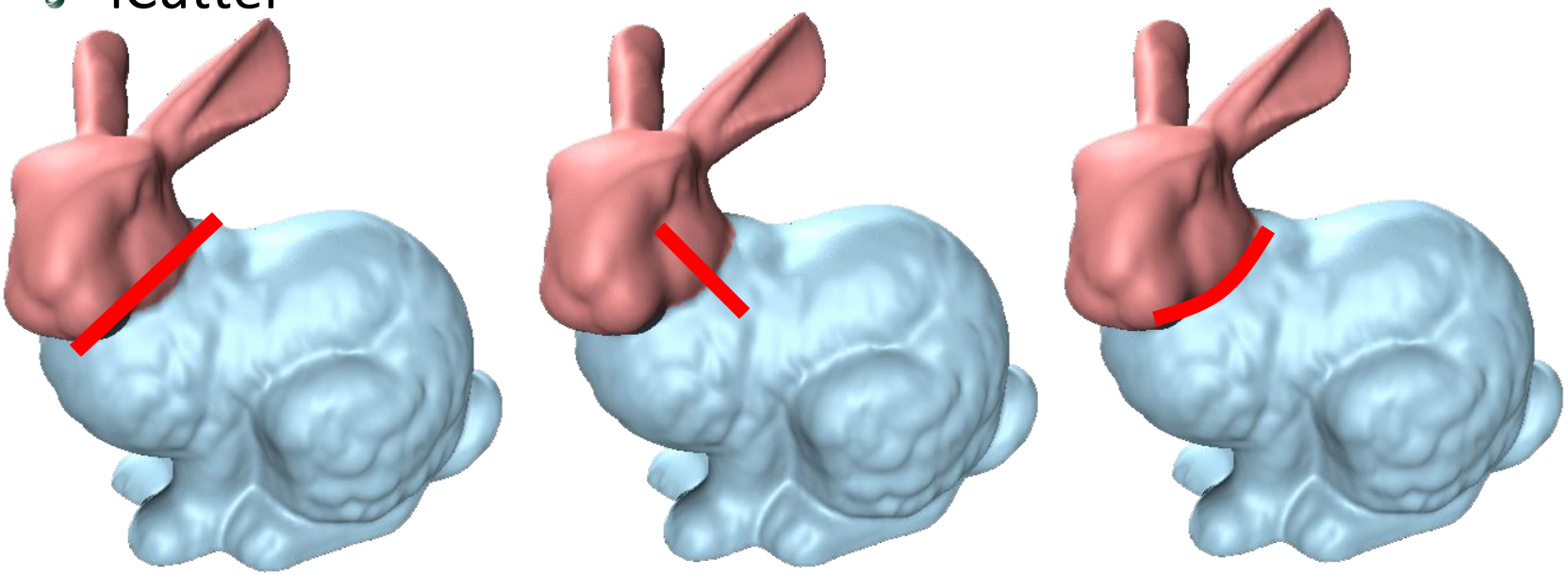
Experimental results

- Running time
  - RT_1 , RT_2 , RT_3 denote the computation time of sampling, scalar field and isoline selection respectively

Model	# Vertex	RT_1 (ms)	RT_2 (ms)	RT_3 (ms)
Feline	49,864	952	921	49
Bunny	34,839	842	858	47
Cow	6,938	172	141	3
Armadillo	25,193	749	484	32
Plank	25,445	609	546	32
Neptune	28,052	687	561	31

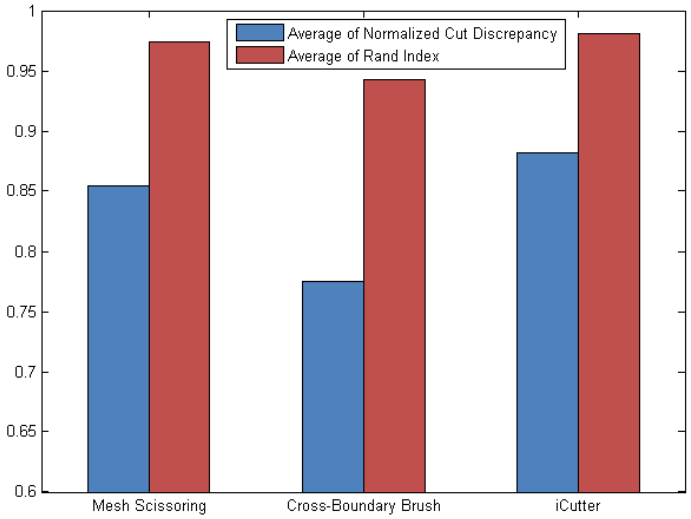
User study

- Compare the performance of three boundary-based cutting tools
  - Mesh scissor [Lee et al. 2005]
  - Cross-boundary brush [Zheng et al. 2010]
  - iCutter

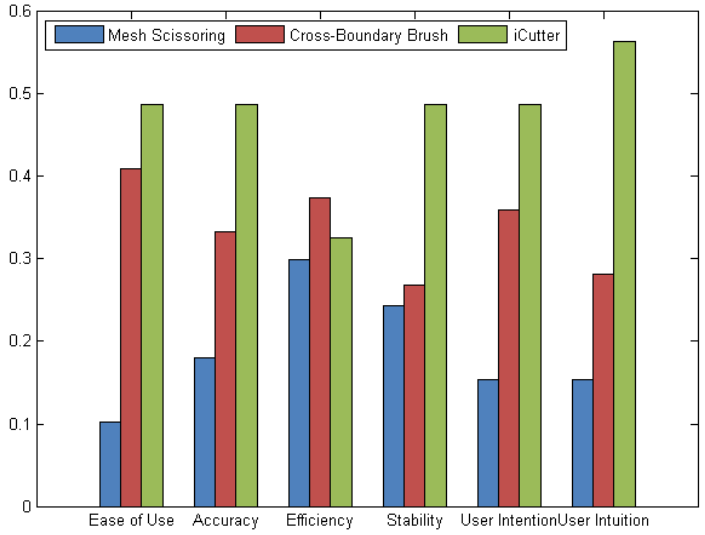


User study

- Analysis



Average measured accuracy



Survey of User feedback

Limitation

- Difficult to cut out parts from smooth surface
- Not suitable for cutting out the patch-type components

Conclusion

- Easy-to-use tool for interactive mesh cutting
- Provide users a favorable experience on cutting mesh surfaces
- **What you draw is what you get!**

Thank you for your listening ！