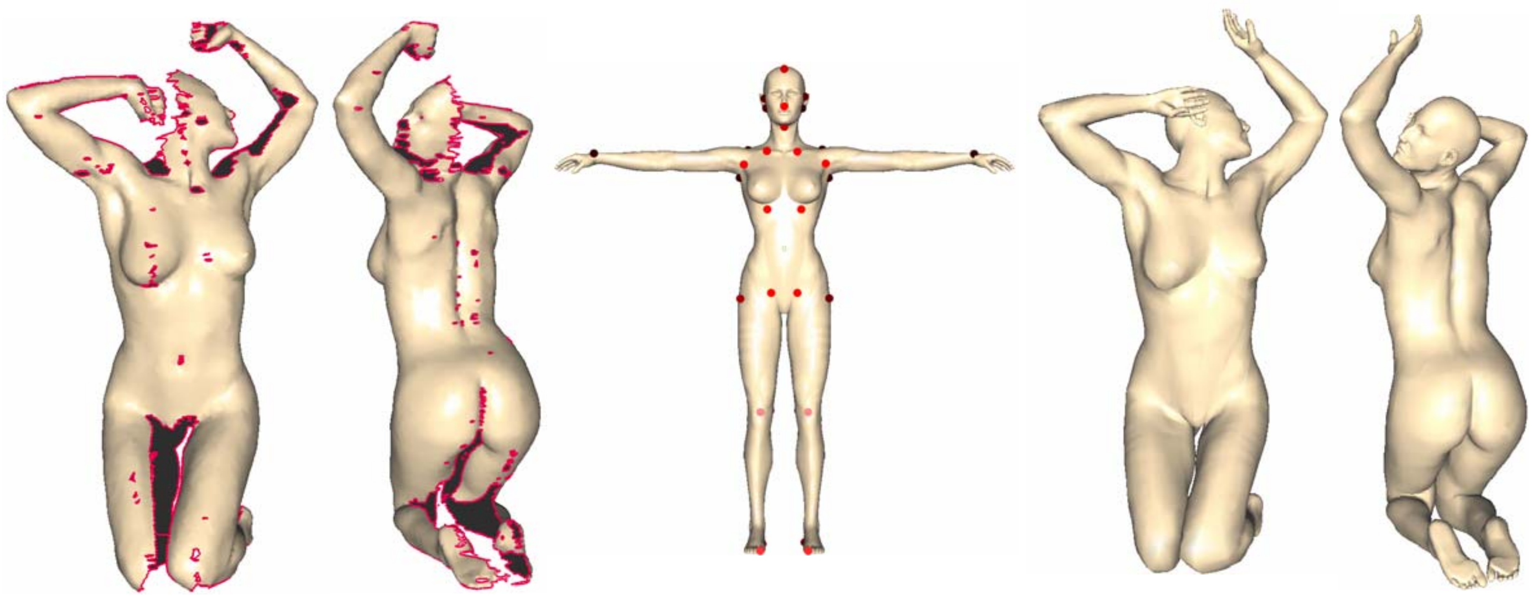
Template Based Mesh Completion

Vladislav Kraevoy   Alla Sheffer

Department of Computer Science

University of British Columbia



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Problem

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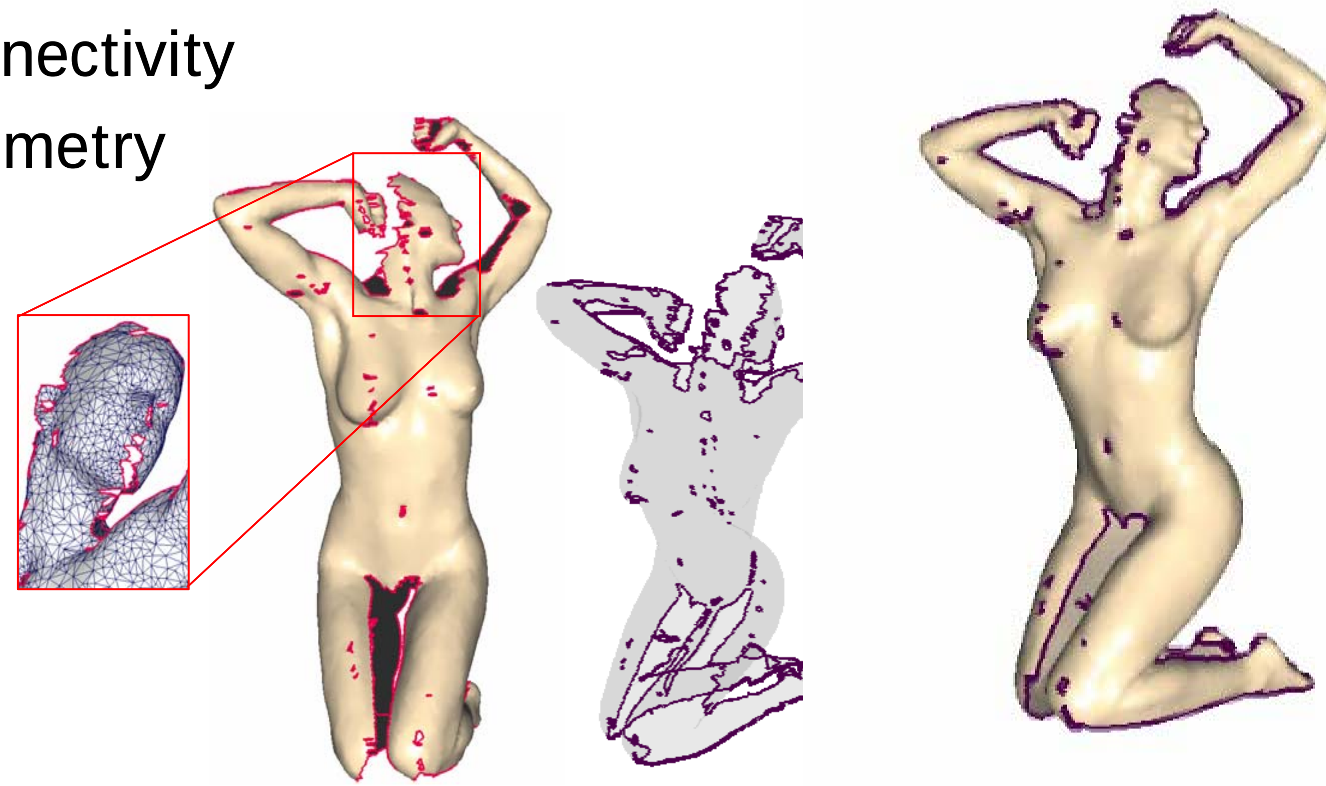
- Given mesh with holes (& multiple components) – complete holes and gaps
  - Topology
  - Connectivity
  - Geometry



- Need global information

Previous work - Completion

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- Local hole completion [Davis et al. 02; Liepa 03;Sharf et al. 04; Levy 03]
  - No use of global info
- Template-based [Allen et al. 02; Allen et al. 03]
  - Constrained cross-parameterization between input and template
  - Not robust
    - Template & input very similar
    - Small holes
- [Anguelov et al. 05] – template + skeleton
  - Handles incomplete models in different poses
  - Need data for all skeleton links

Previous Work - Parameterization

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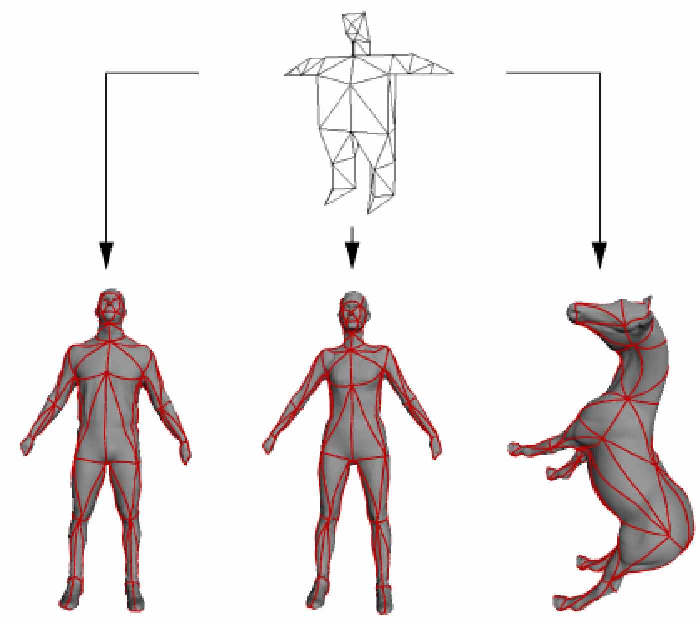
- Parameterization of surfaces with boundaries – 2D [Floater & Hormann 04]
  - Unclear what to do with “exterior” boundary
  - Do not handle multiple components
  - High distortion
- Cross-parameterization [Praun et al. 01; Kraevoy & Sheffer 04; Schreiner et al. 04]
  - Use base mesh
  - Closed models or 1-to-1 hole correspondence



Completion - Our Approach

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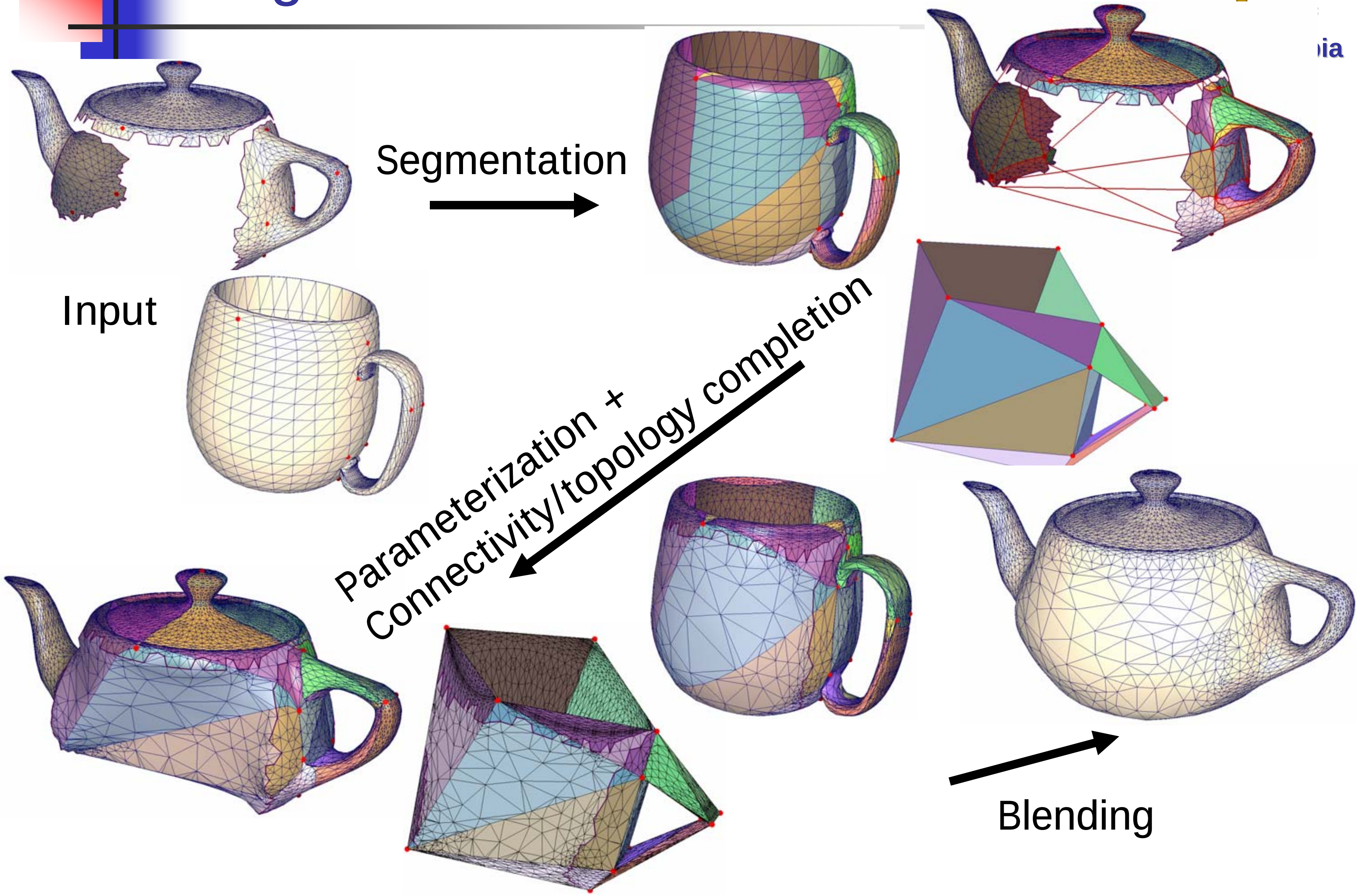
- Cross-parameterization between incomplete meshes
  - Use base mesh
  - Robust: large holes, any number of components & holes
  - Low distortion – accurate completion
- Global completion
  - One to one mapping between completed model & template – topology preservation
  - Maximal use of global info
- Local completion
  - Supports large (1M+) meshes
  - Supports different genus

Stages


Segmentation
Input
Parameterization +
Connectivity/topology completion
Blending

Segmentation

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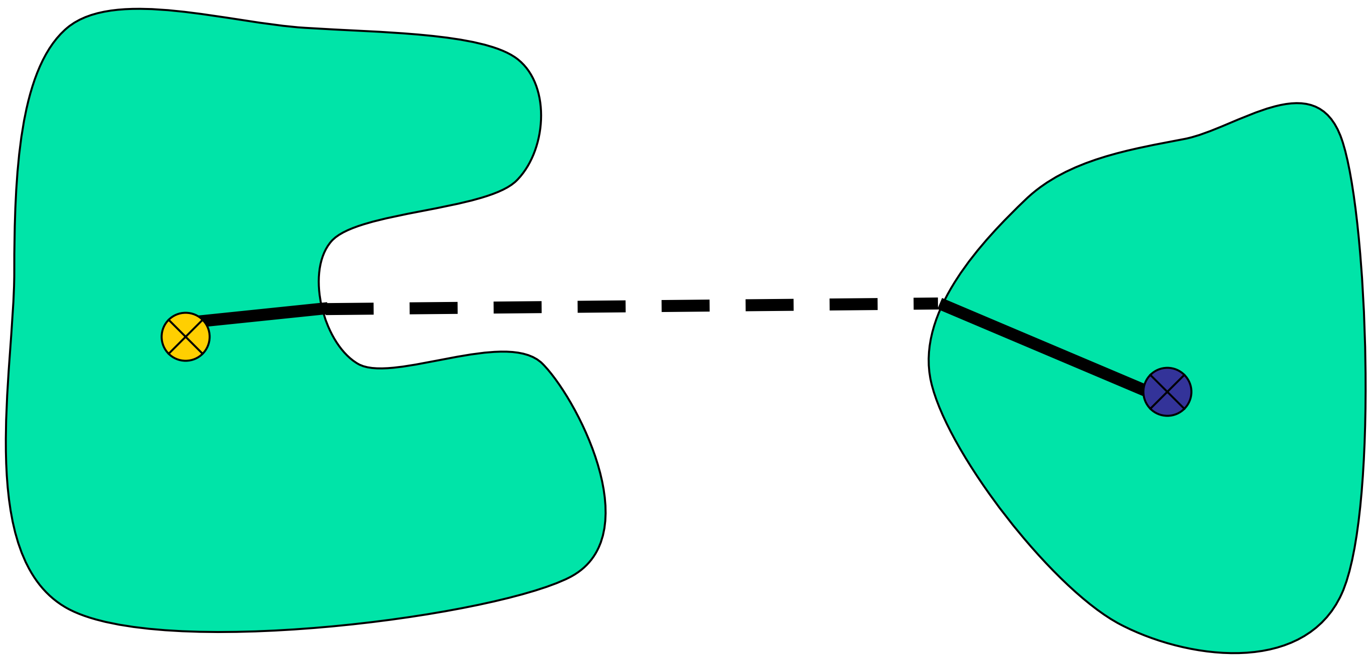
- Must support paths between markers on different components
  - Use *virtual* edges between boundary vertices



Closed Meshes - Segmentation

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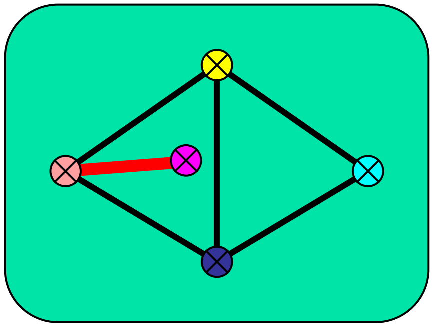
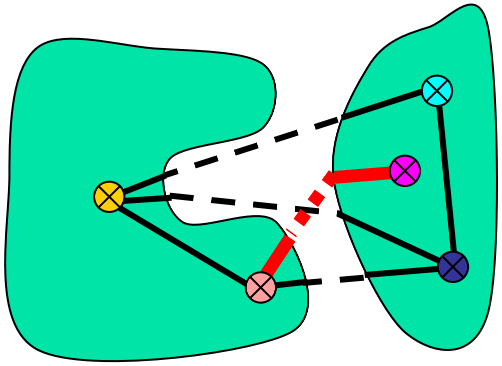
- Incremental [Praun et al. 01; Krayevoy et al. 2003; Kraevoy and Sheffer 2004; Schreiener et al. 2004]
- Add pairs of matching paths between feature vertices
  - Validity checks
    - Intersection
    - Order (Orientation)
    - Blocking
  - Add vertices when necessary





Segmentation

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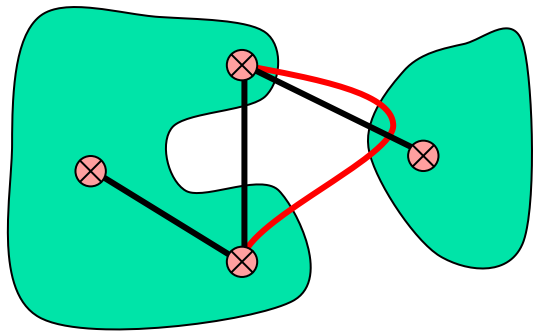
- Limit paths structure – legal paths
  - One virtual edge (at most) per path
  - 3 types
    - Interior
    - Cross-hole
    - Cross-gap



- Segment template first
  - Introduce legal path one by one
- Construct base-mesh from template segmentation

Segmentation - Input

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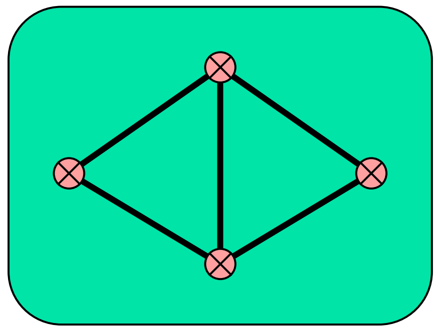
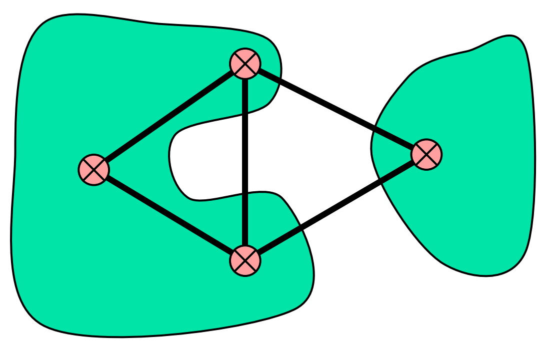
- Generate spanning tree inside each component
  - Use only interior paths
- Connect components by spanning tree
  - Use cross-gap paths
- Add remaining paths
  - Use all 3 types of legal paths
- Add vertices when necessary

- **Guaranty consistency**



Template segmentation



Segmentation - Output

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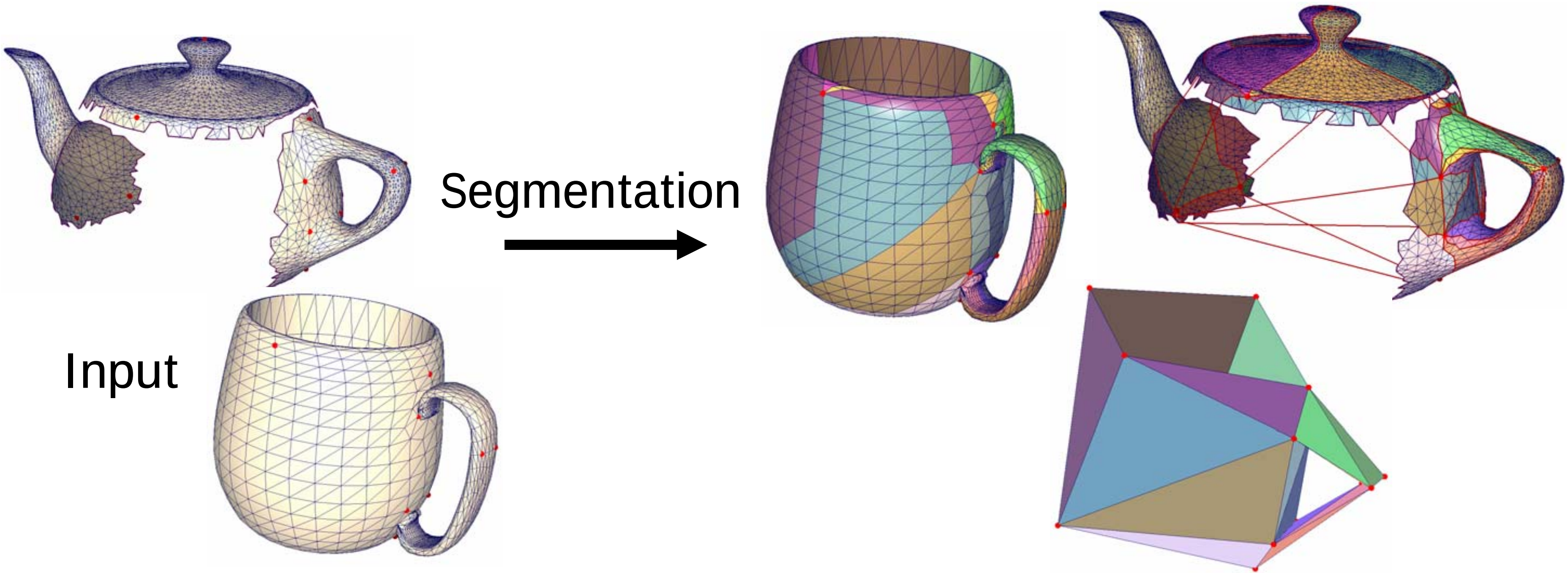

- Each patch is *connected planar graph*

Initial Parameterization

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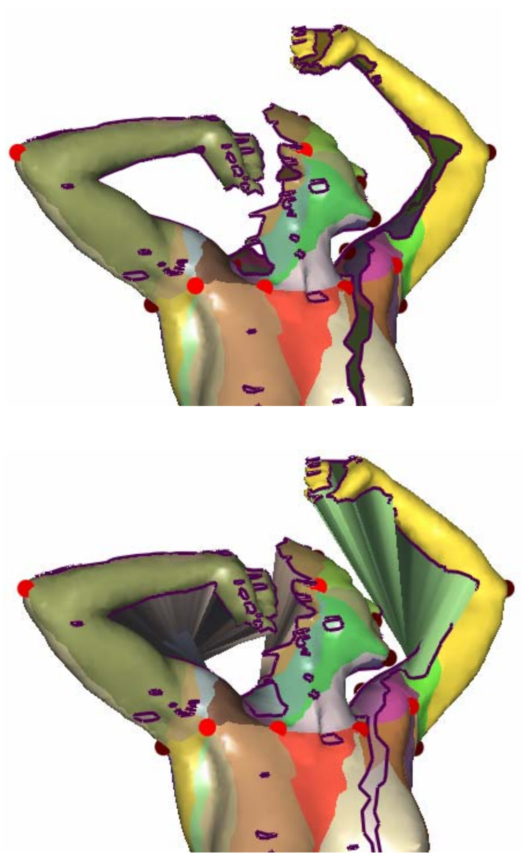
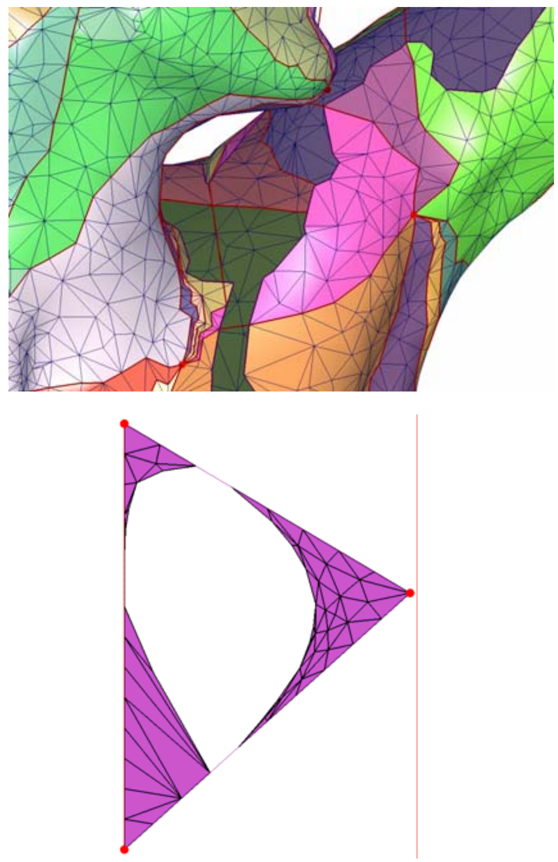
- Map each patch to base triangle - uniform [Tutte 63]
  - Bijective
- Triangulate gaps & holes on base





Parameterization + Triangulation

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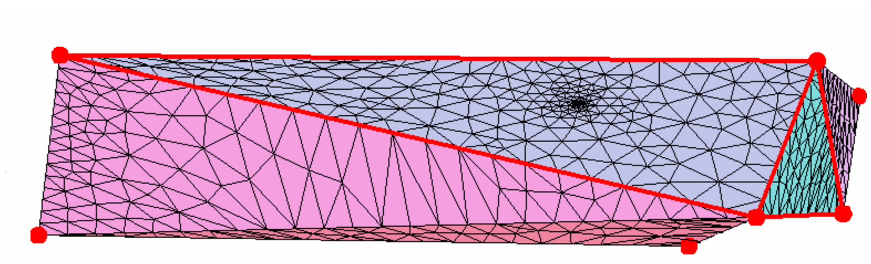
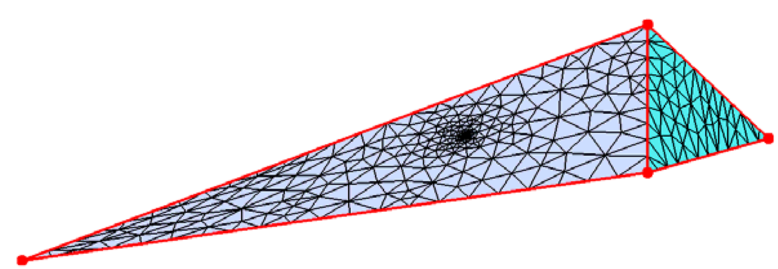
- Iterative improvement
  - Need to allow migration between base triangles
  - Use overlapping domains
  - Our choice – unfold 2 adjacent triangles into quad
    - [Guskov et al. 00] – unfold to equilateral diamond
    - Our – preserve triangle shape (when possible)





Parameterization + Triangulation

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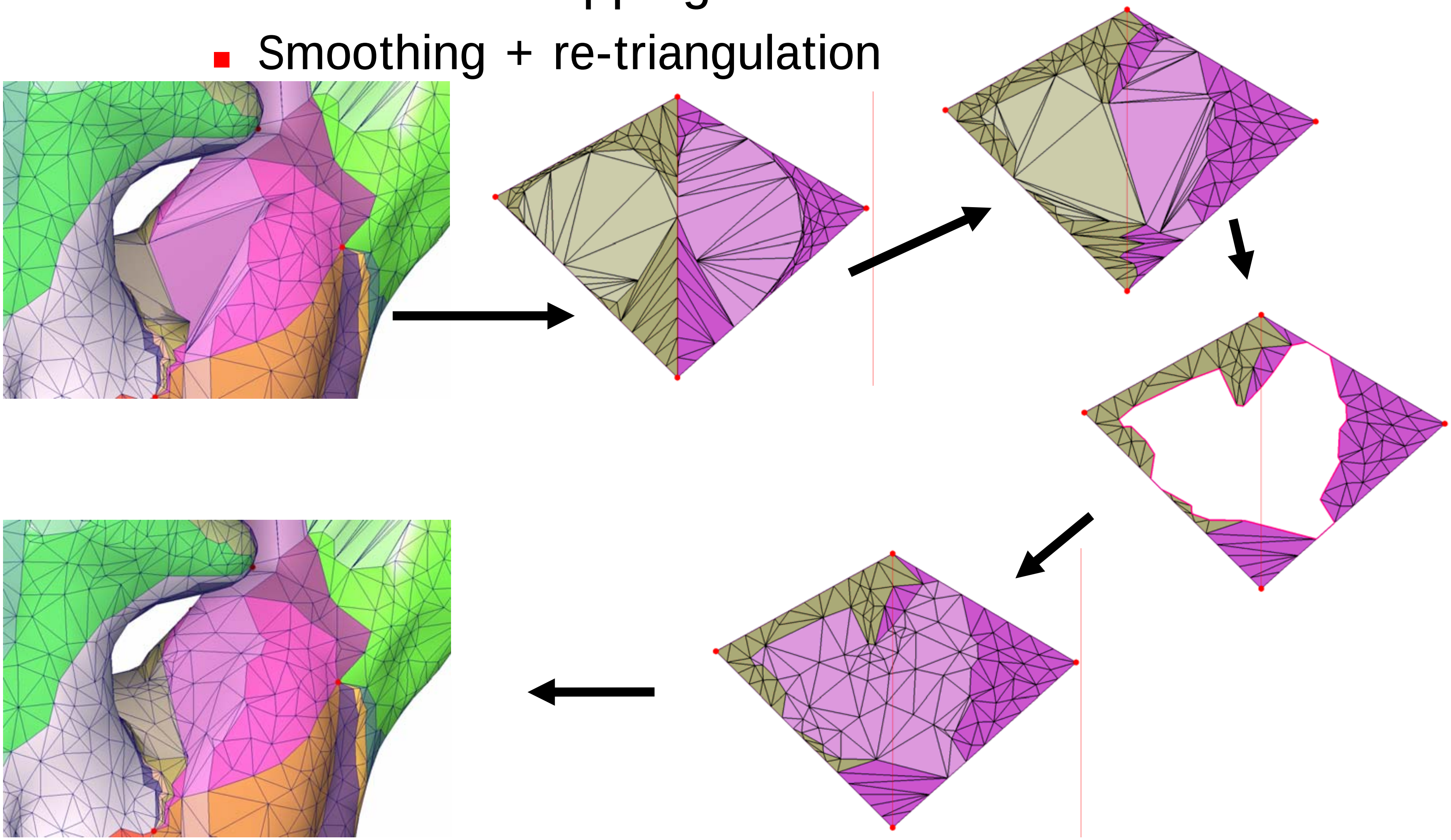
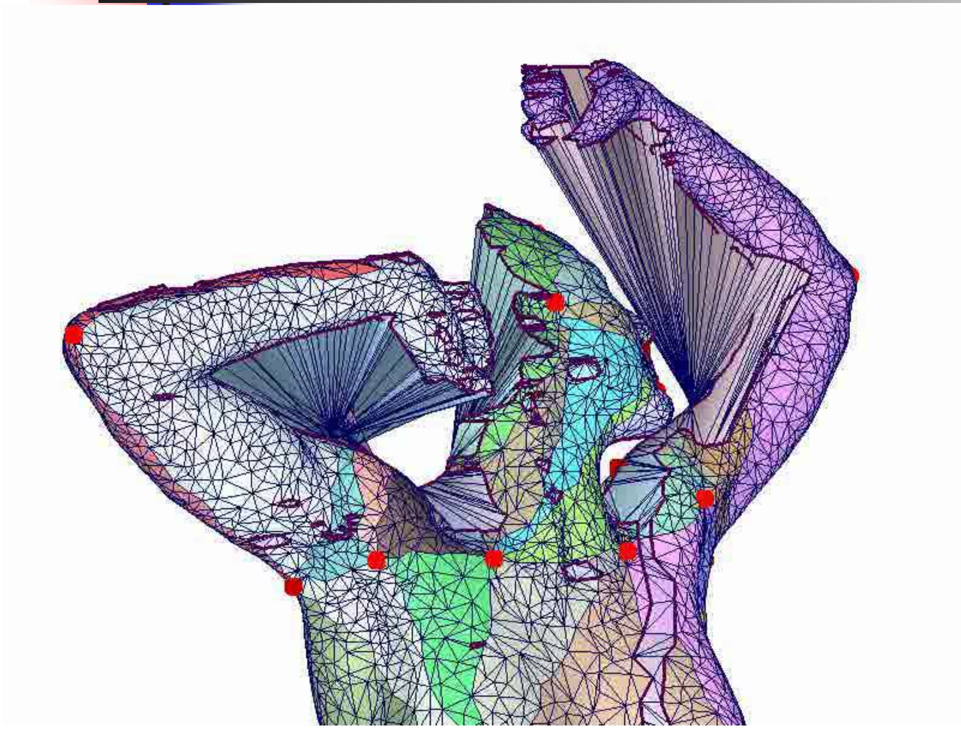
- Iterate on overlapping domains
  - Smoothing + re-triangulation



Iterative improvement



Results - Female

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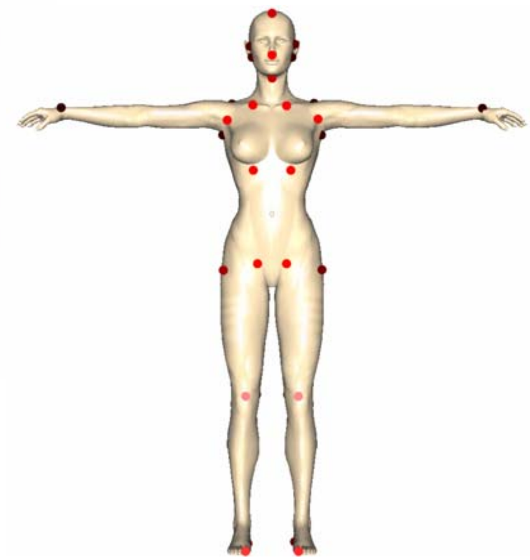
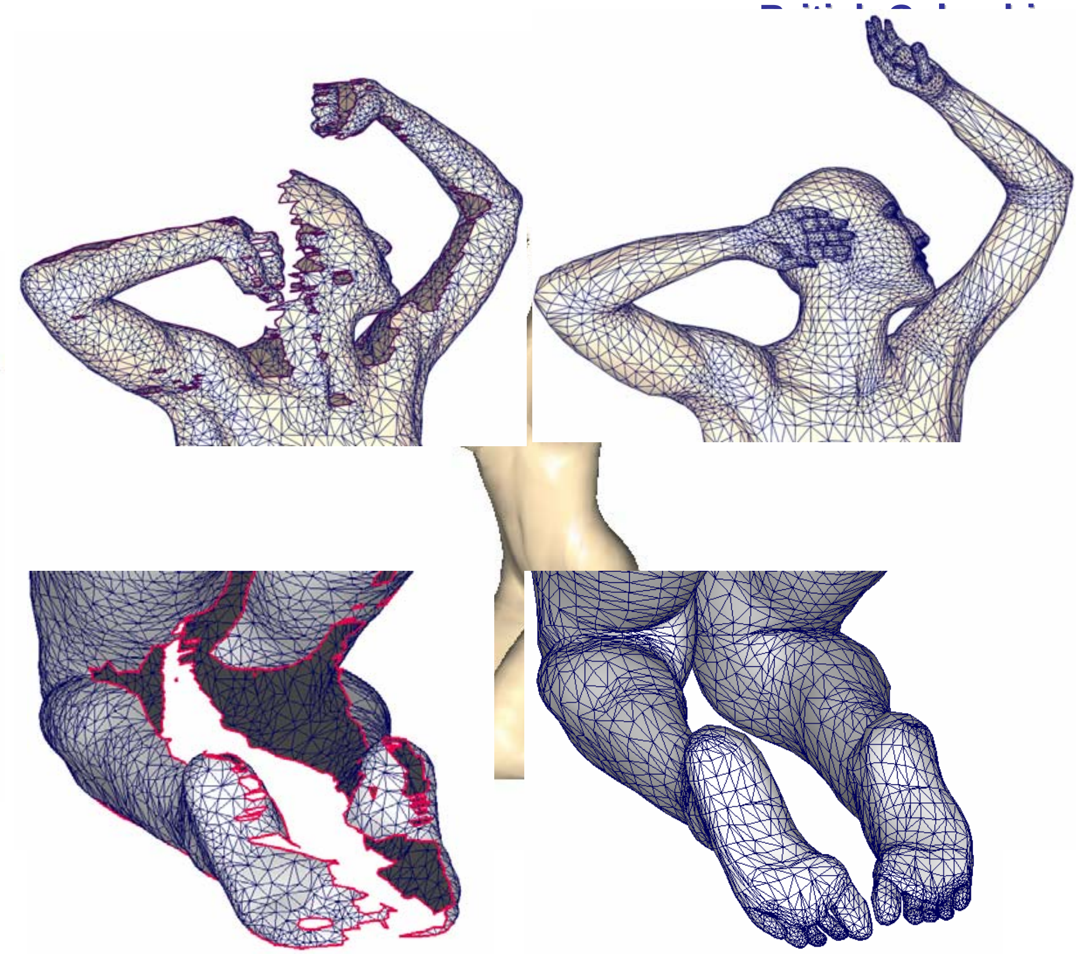


Template
(Poser)



Sizes: 20455/27562	Markers: 39	Time 45s

Results – Mutual Completion

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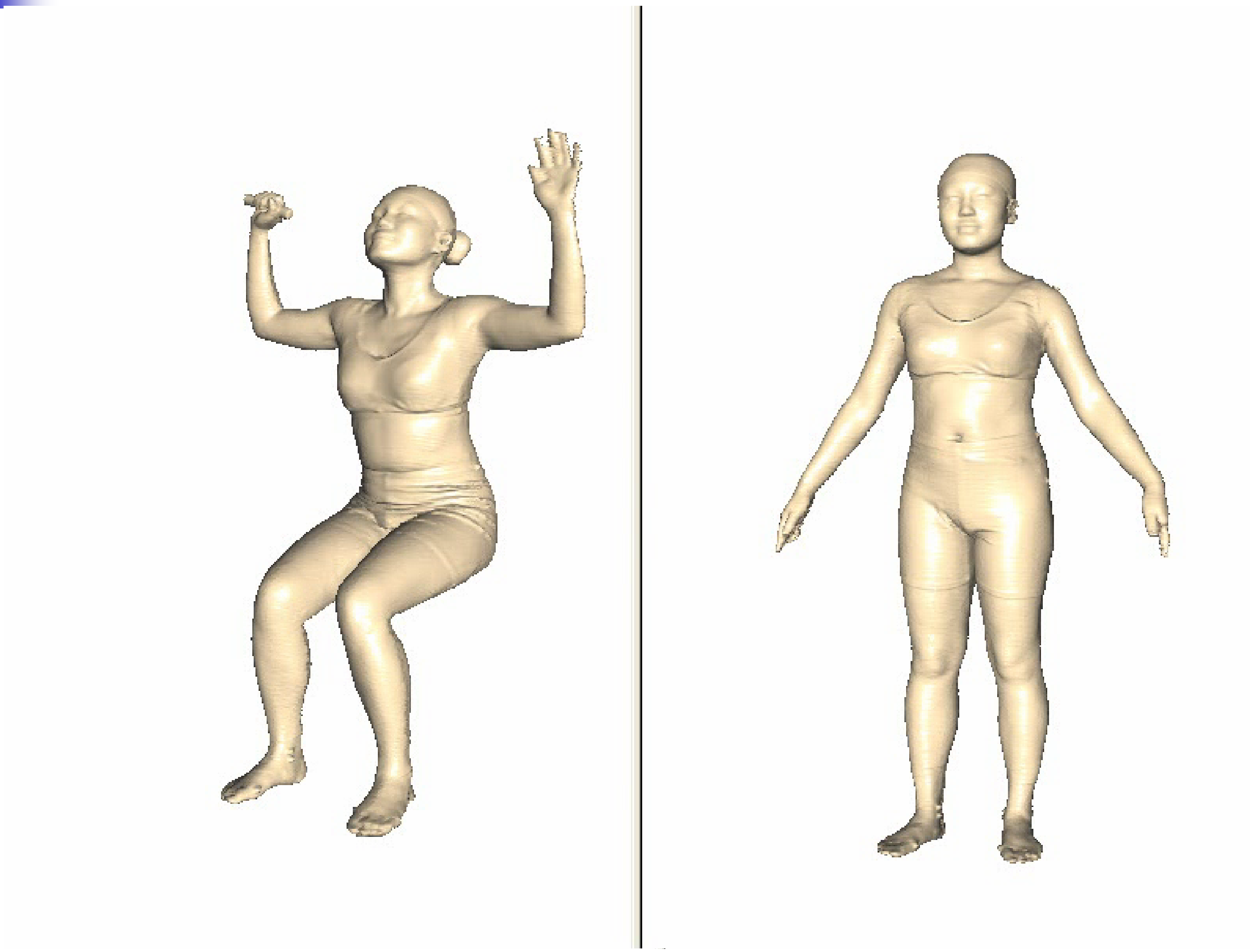

Sizes: 195660/230831	Components: 2/2	Markers: 37	Time: 472s

“Templateless” Completion

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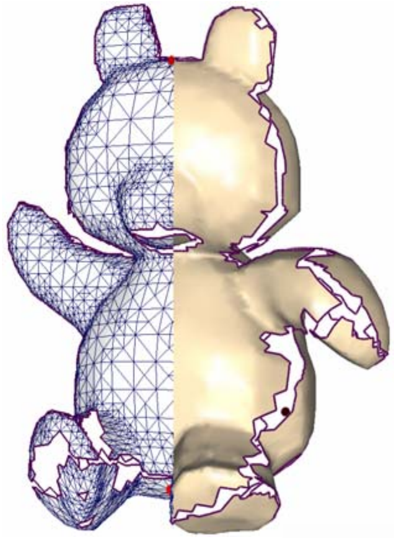
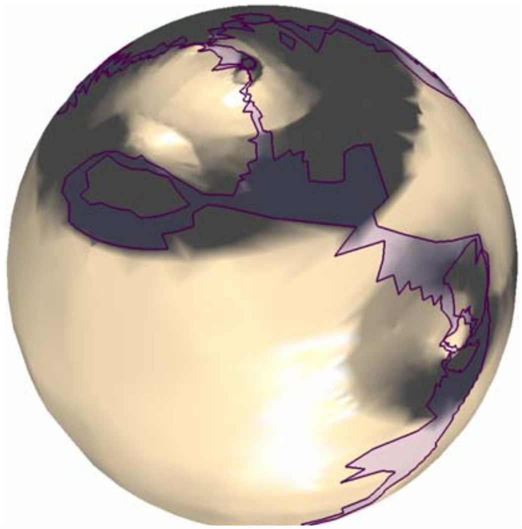
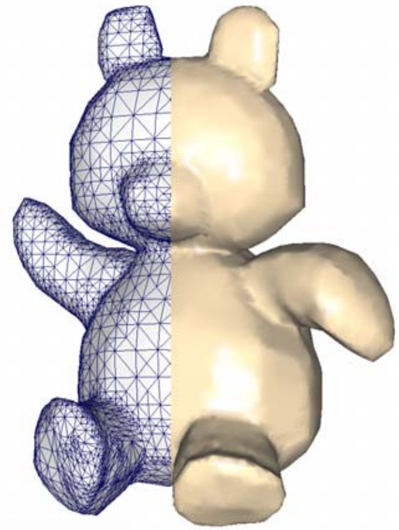
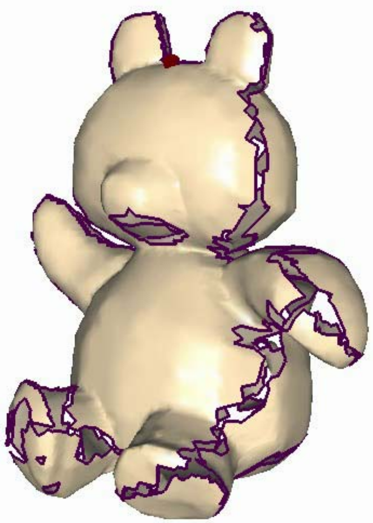






11 Components



Results – Local Completion

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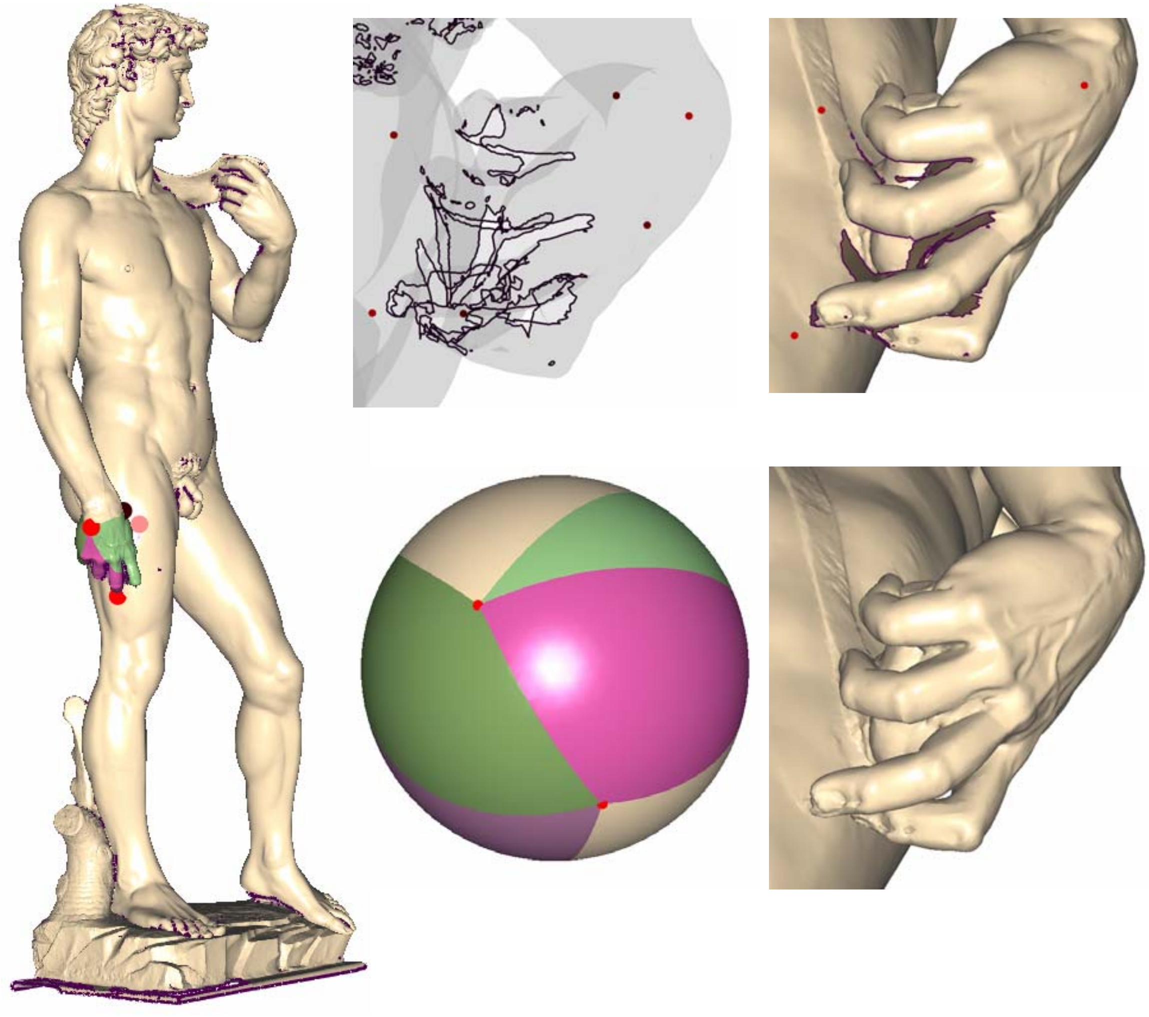

Template Based Completion

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- Robust - Handles very complex geometries
  - Large gaps and holes
  - Large shape/pose differences between template & input
    - Including templates with only topology information
- Efficient - O(nlogn)
- Supports local completion
  - Different genus
  - Large models/Models with no adequate global template

Issues/Future

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- Automatic marker placement
- Template & input with different genus/connectivity
  - Correcting input “errors”

Questions?

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