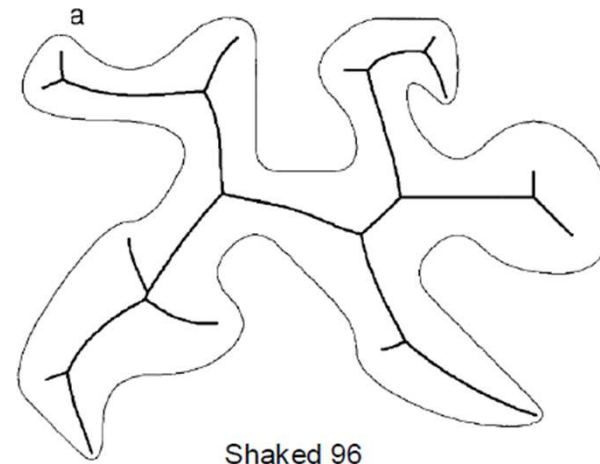


Mid-structures of Shapes

- A Brief Review

Blum 67

- “A Transformation For Extracting New Descriptors of Shape”
- Locus of points equidistant from contour
- Medial Axis
- Symmetric Axis
- Skeleton
- Shock Graph



Why do we want mid-structure representation?

- Dimensionality reduction
- Shape understanding

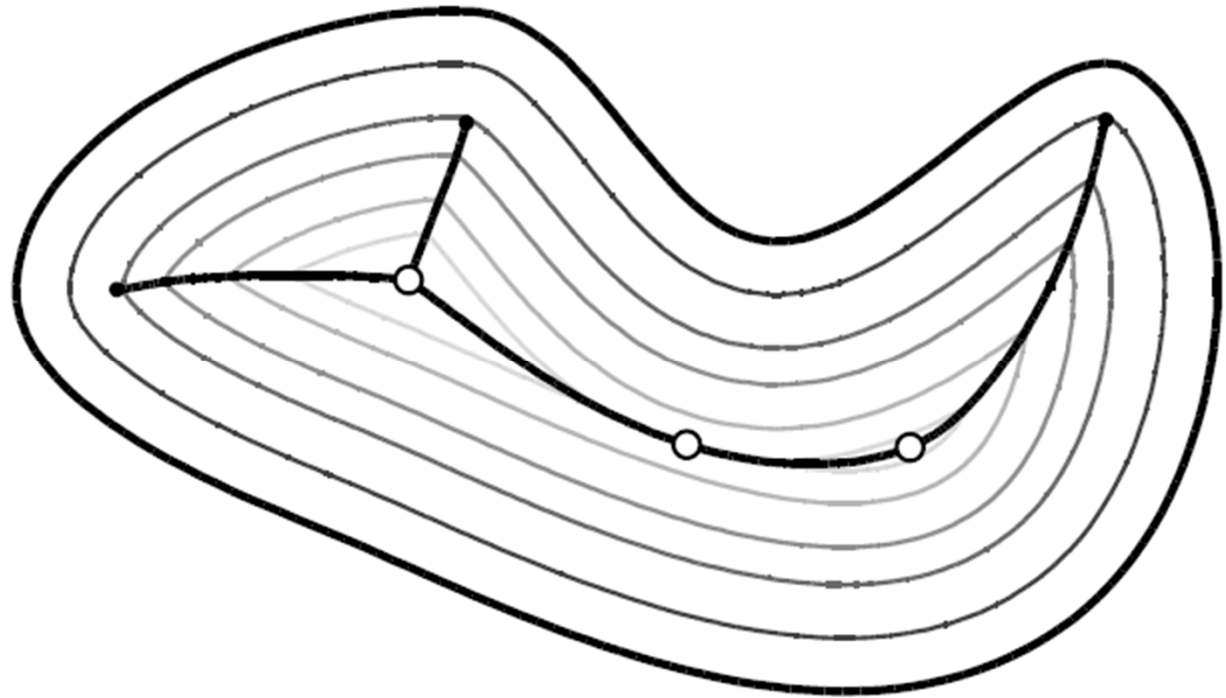
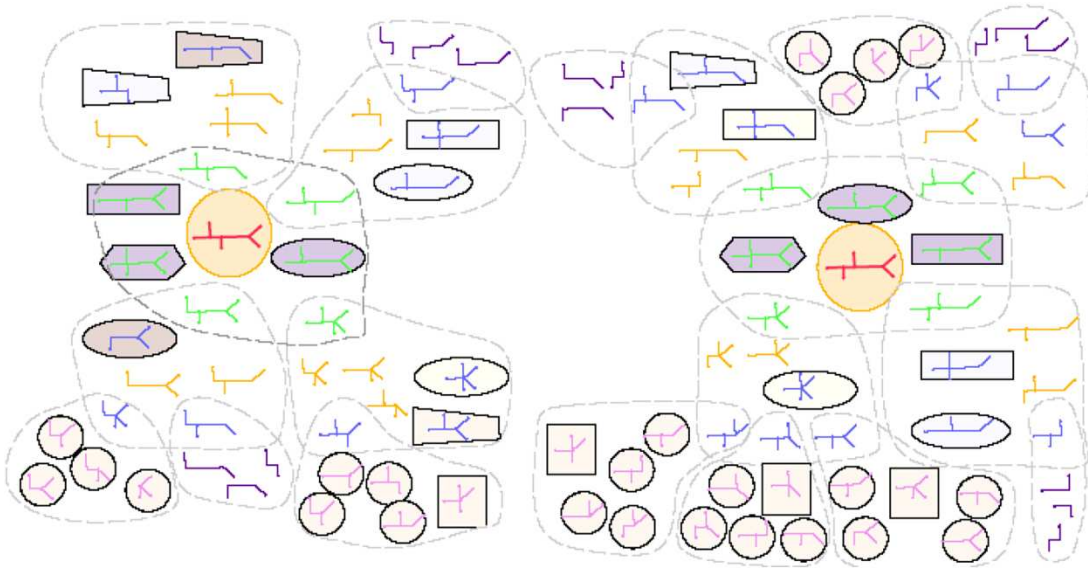


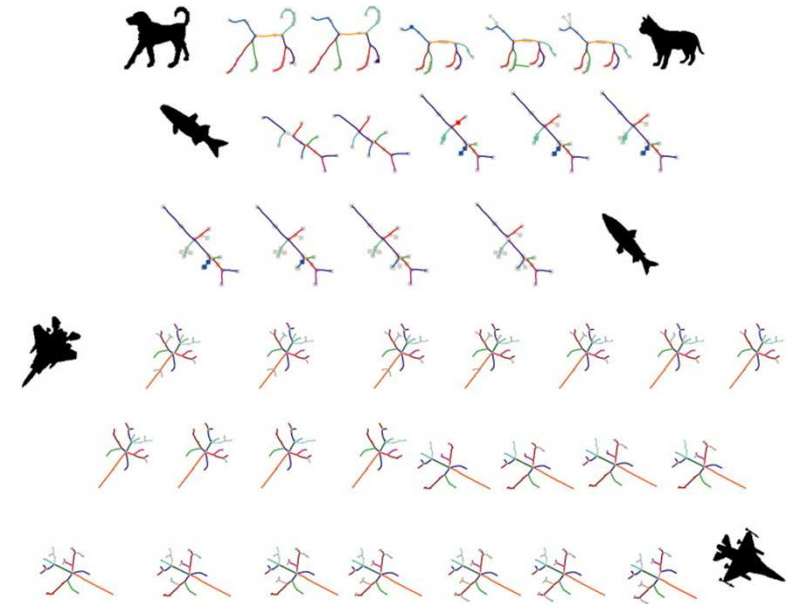
Image source: <http://w3.impa.br/~paesleme/MedialAxis/MedialAxis.html>

Why do we want mid-structure representation?

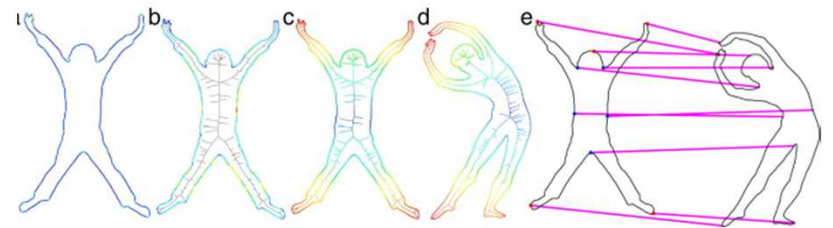
- Dimensionality reduction
- Shape understanding
- Shape matching



[Sebastian 01]



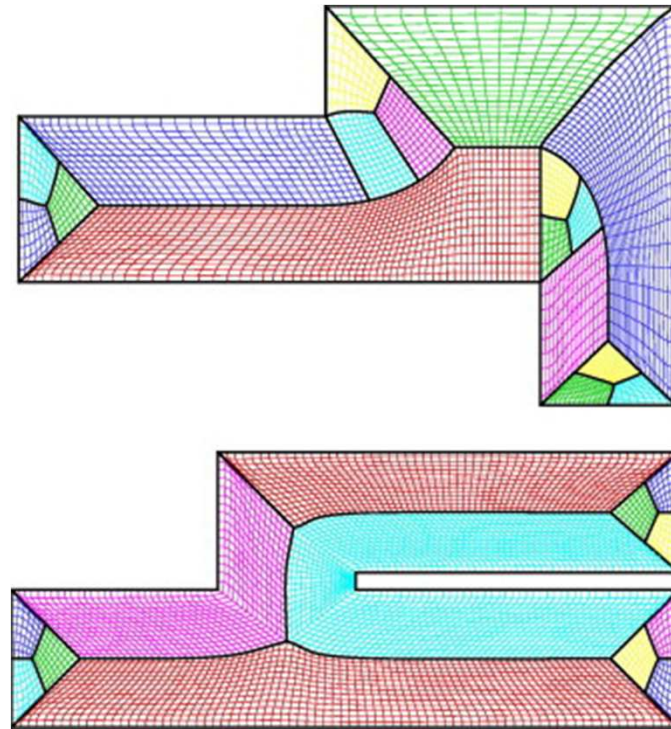
[Kimia 2003]



[Liu et al. 2011]

Why do we want mid-structure representation?

- Dimensionality reduction
- Shape understanding
- Shape matching
- Solid modeling



[Xia and Tucker 2011]

Why do we want mid-structure representation?

- Dimensionality reduction
- ...
- Smoothing or sharpening of shape

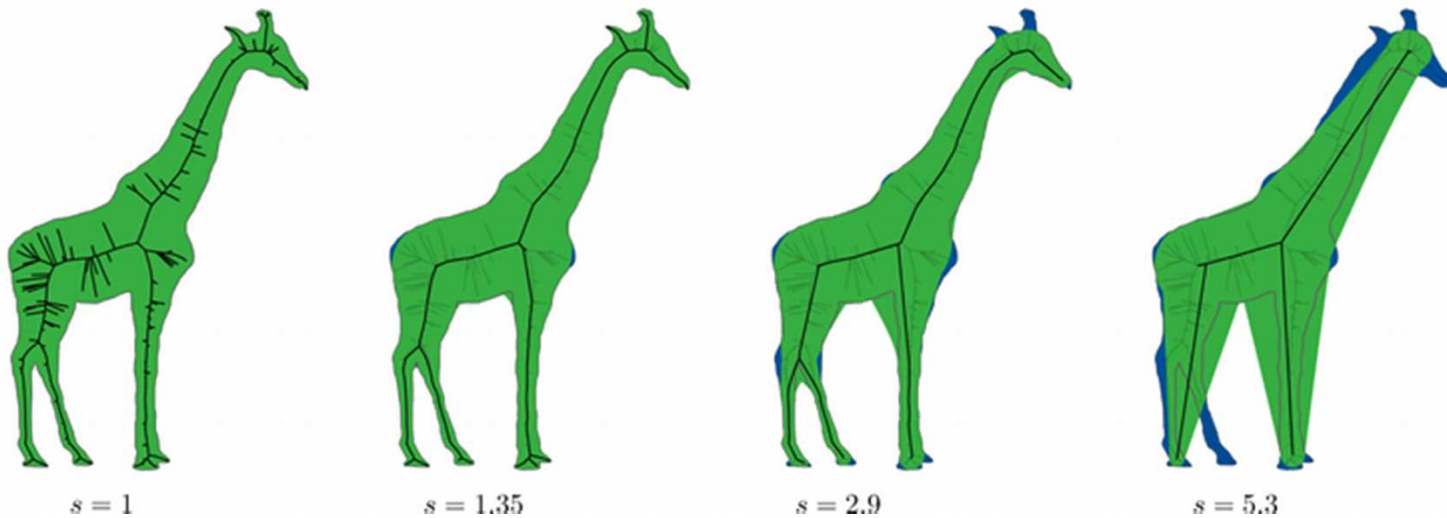
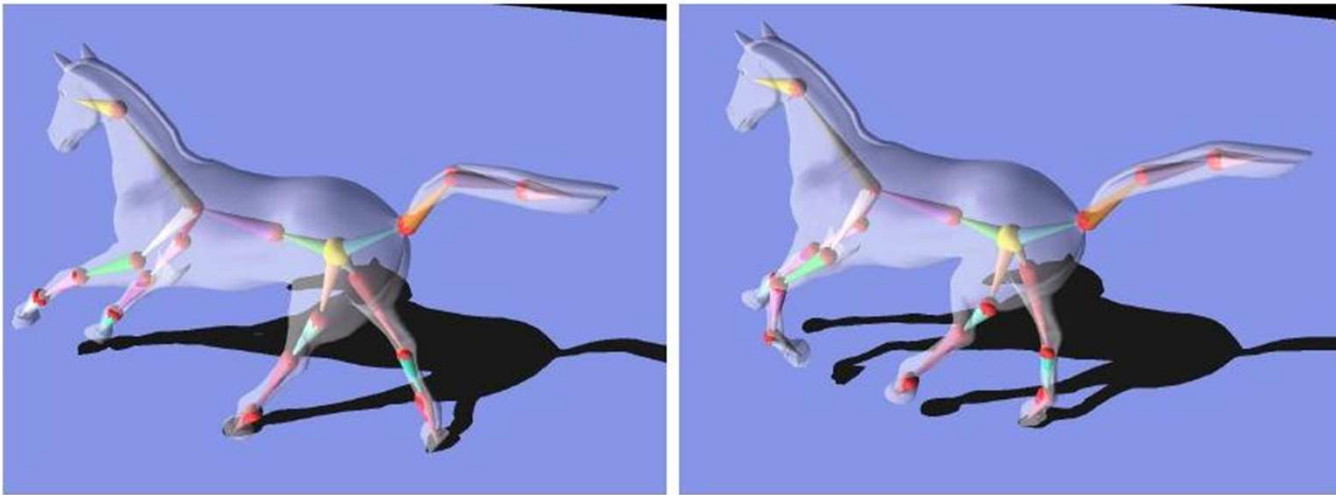


Image source: http://www.agg.ethz.ch/research/medial_axis

Why do we want mid-structure representation?

- Dimensionality reduction
- ...
- Smoothing or sharpening of shape
- Skeleton-based animation

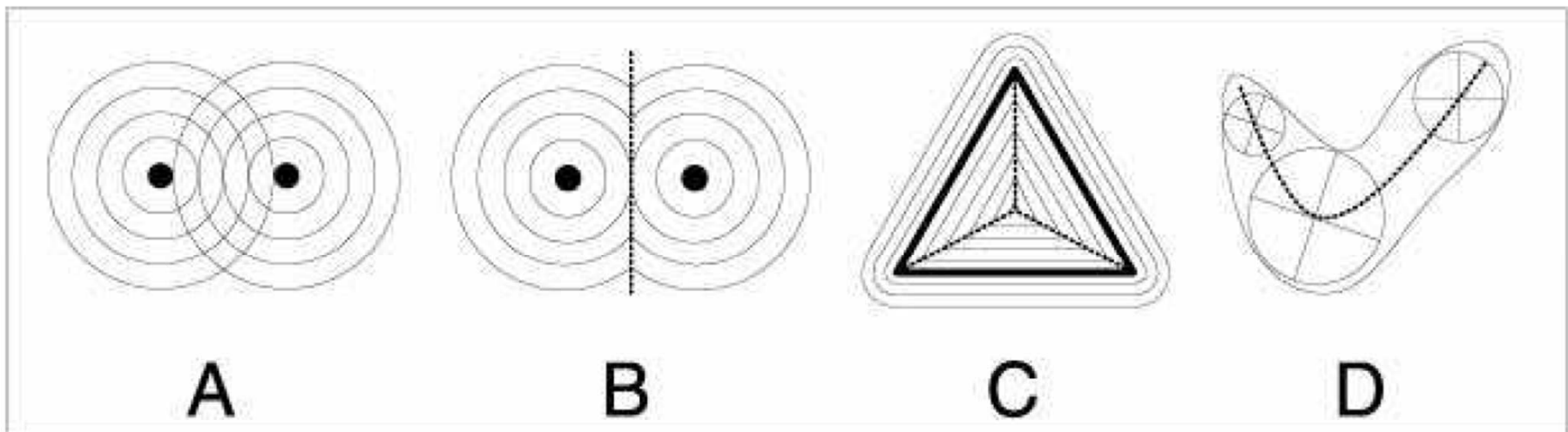


[Aguilar et al. EG2008]

Different Definitions

- Locus of points equidistant from contour
- Grass-fire, prairie-fire, wave-front collision
- Locus of centers of maximal circles
- Local maxima in distance transform
- Result of topological preserving thinning
- Ridges in envelope of cones (apexes on contour)
- ...

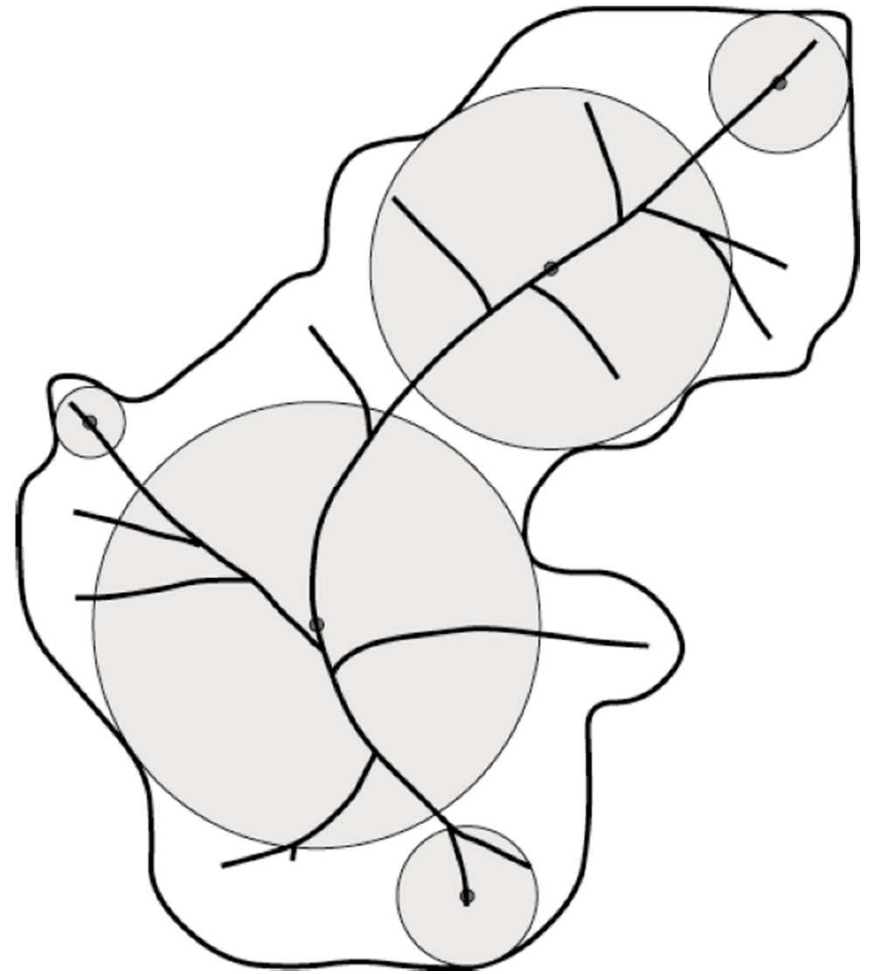
Pictorial Definitions



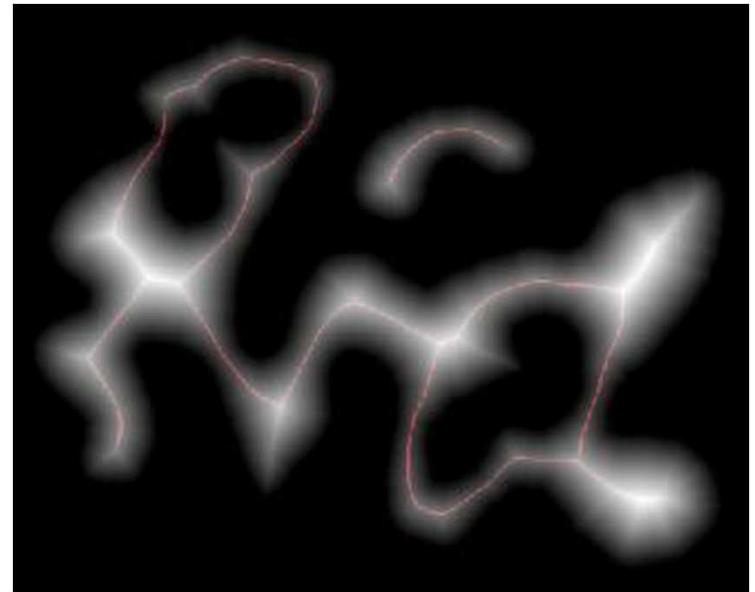
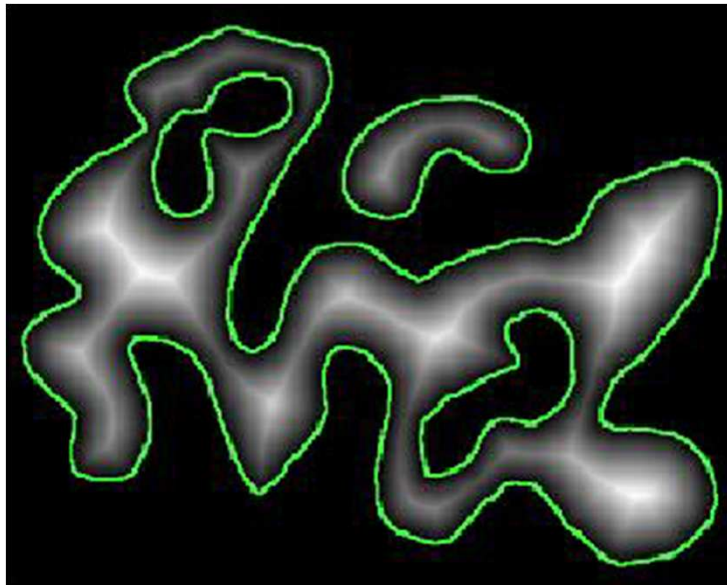
van Tonder

Medial Axis Transform

- The medial axis of a planar region S consists of all centers of maximum disks in S .
- This transformation is invertible!



Distance Transform

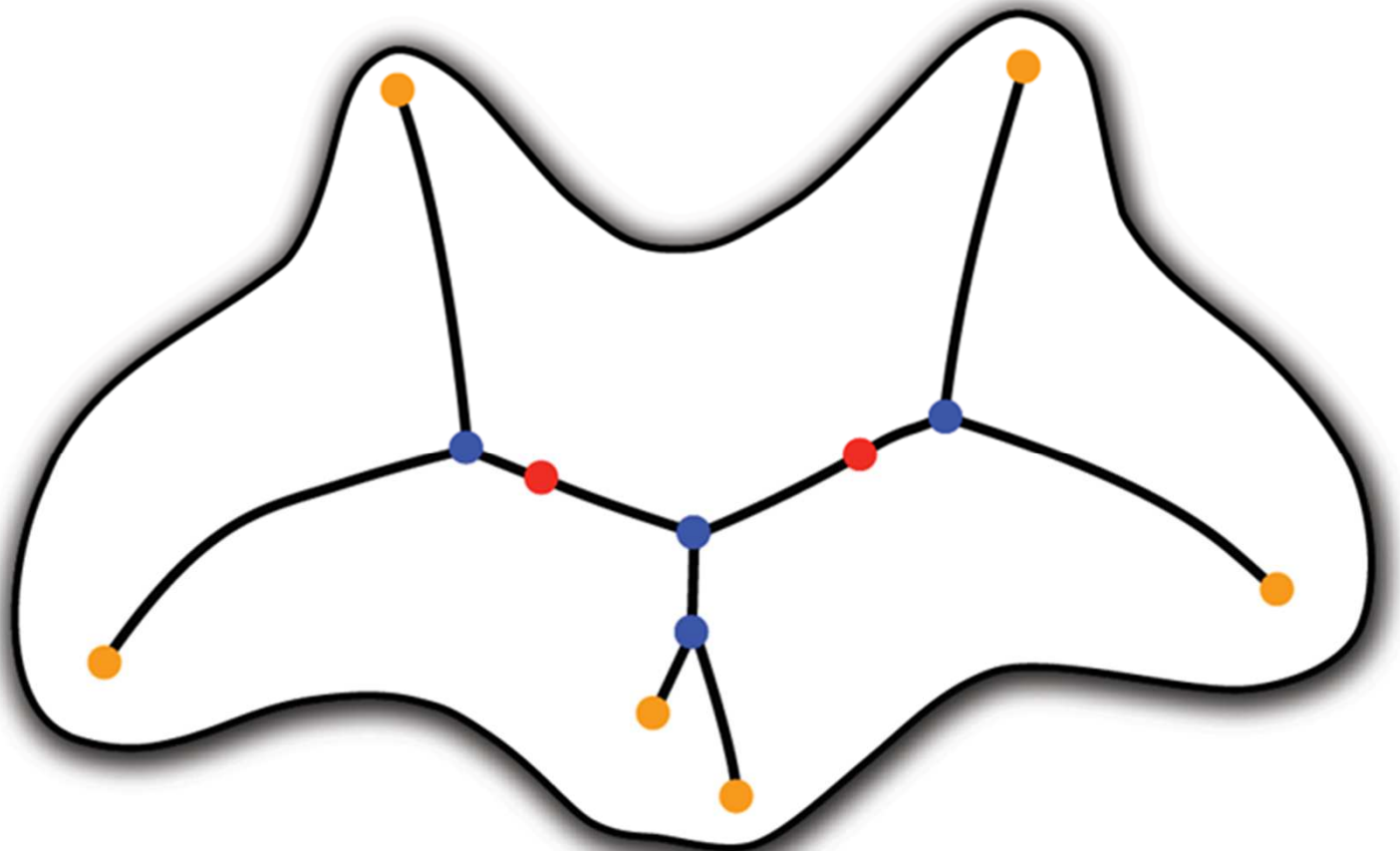


Skeleton located at local maxima of the distance field

Exo-Distance/Skeleton



Classes of Points in Skeleton



3D Medial Axis

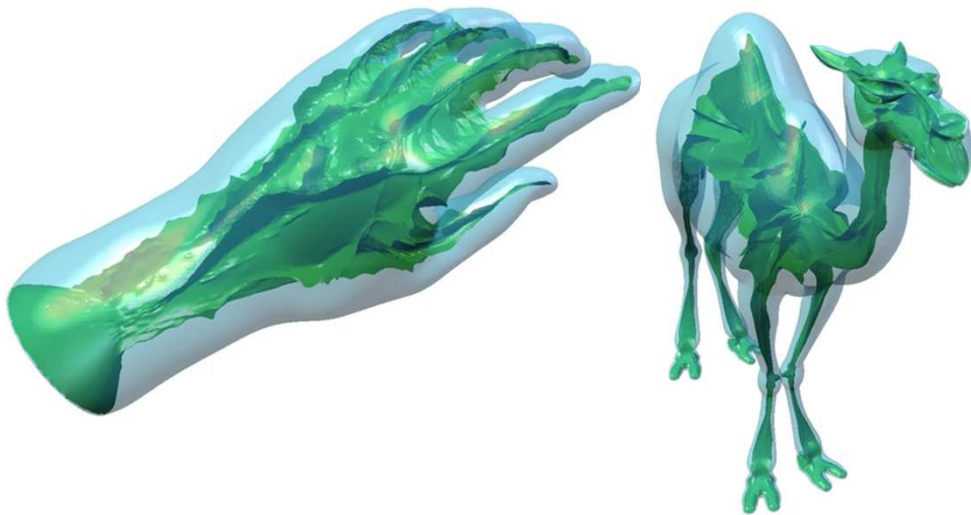
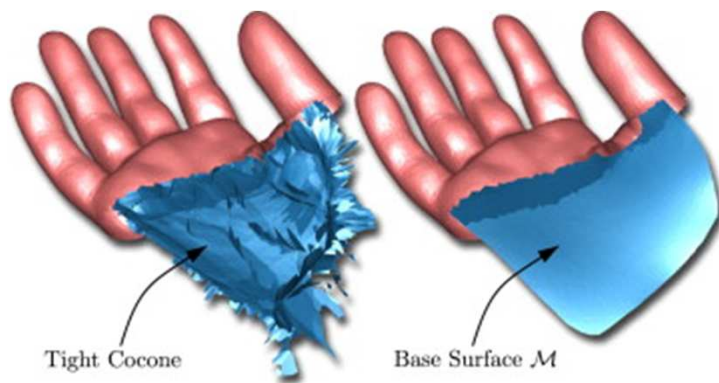
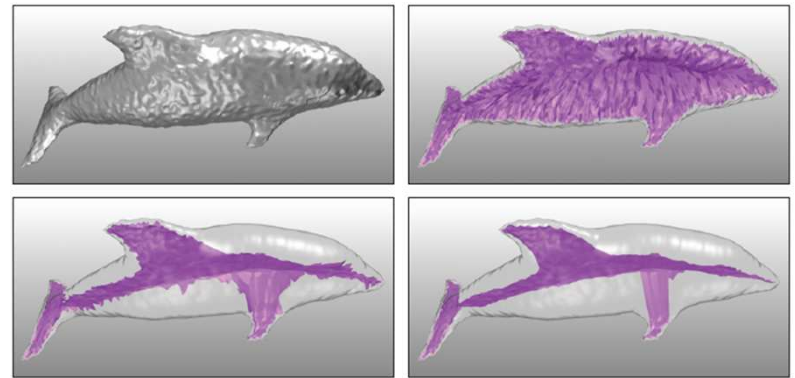
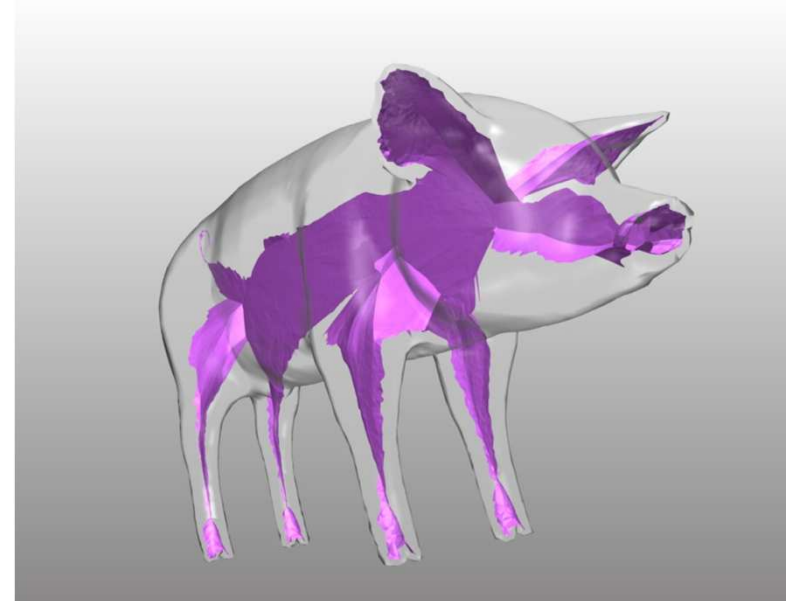


Image source: <http://www.riken.jp/brict/Yoshizawa/Research/Skeleton.html>

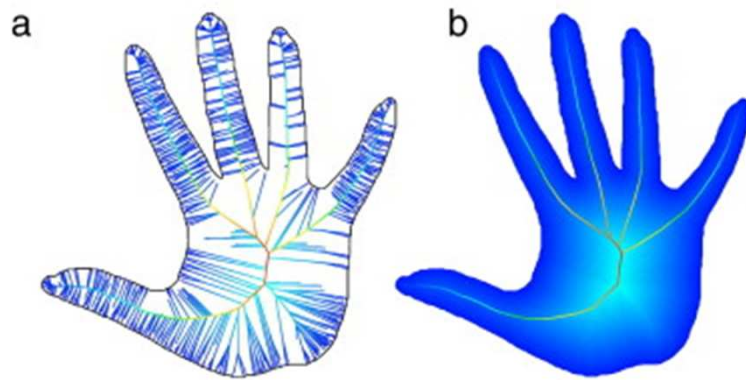


[Martin and Cohen CG10]

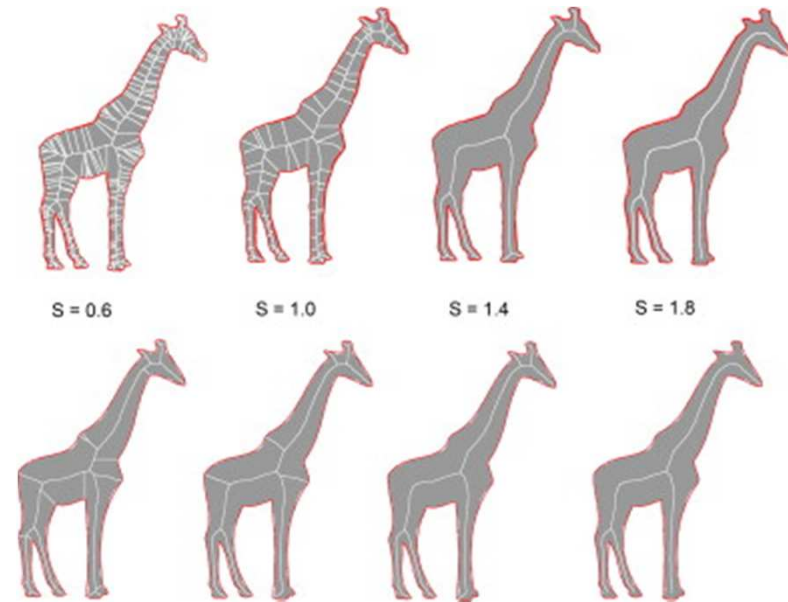


Discrete scale axis [Miklos et al. SIGGRAPH10]

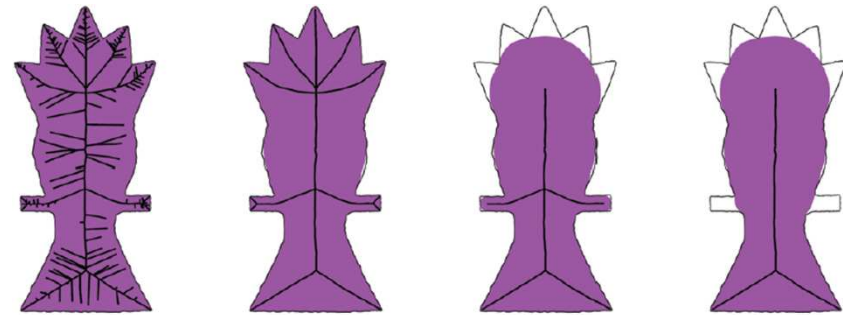
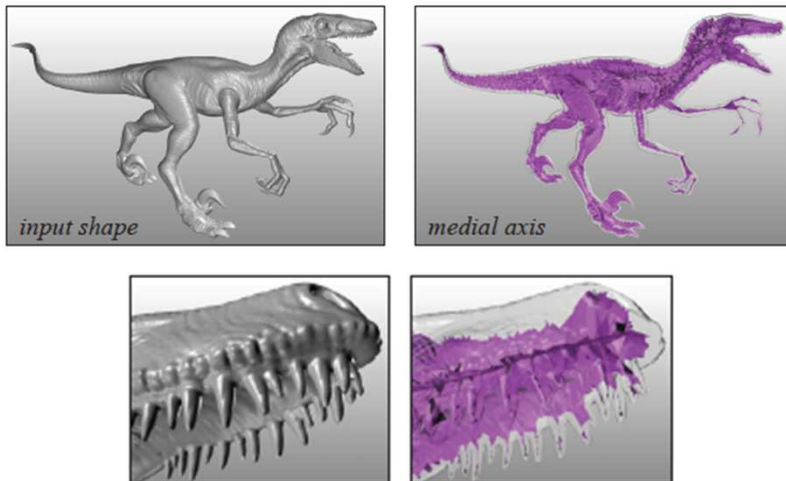
Medial Axis is Sensitive to Noise!



[Liu et al. CAD11]

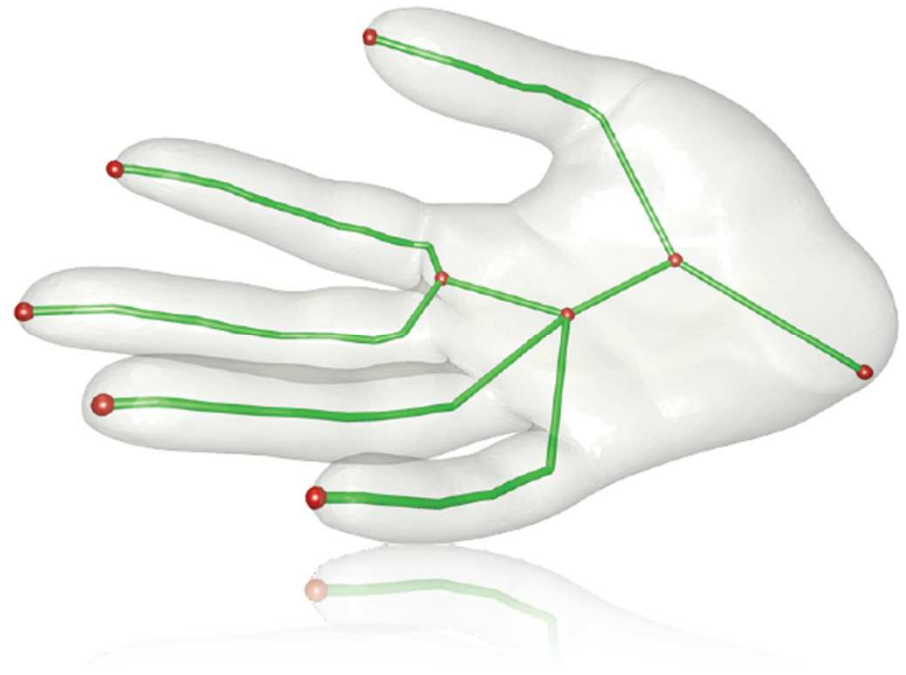


[Montero and Lang CG12]

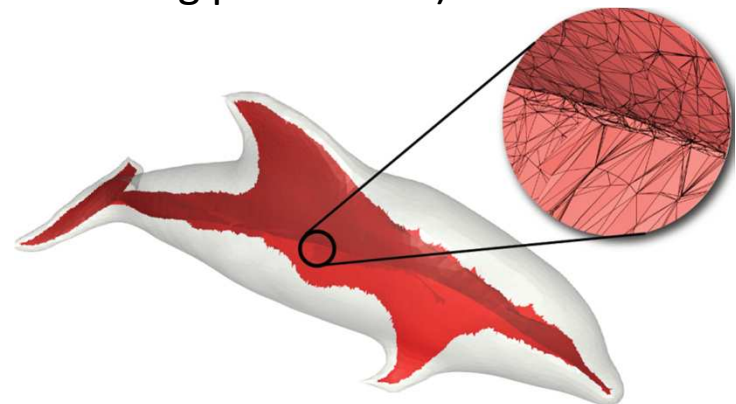


Discrete scale axis [Miklos et al. SIGGRAPH10]

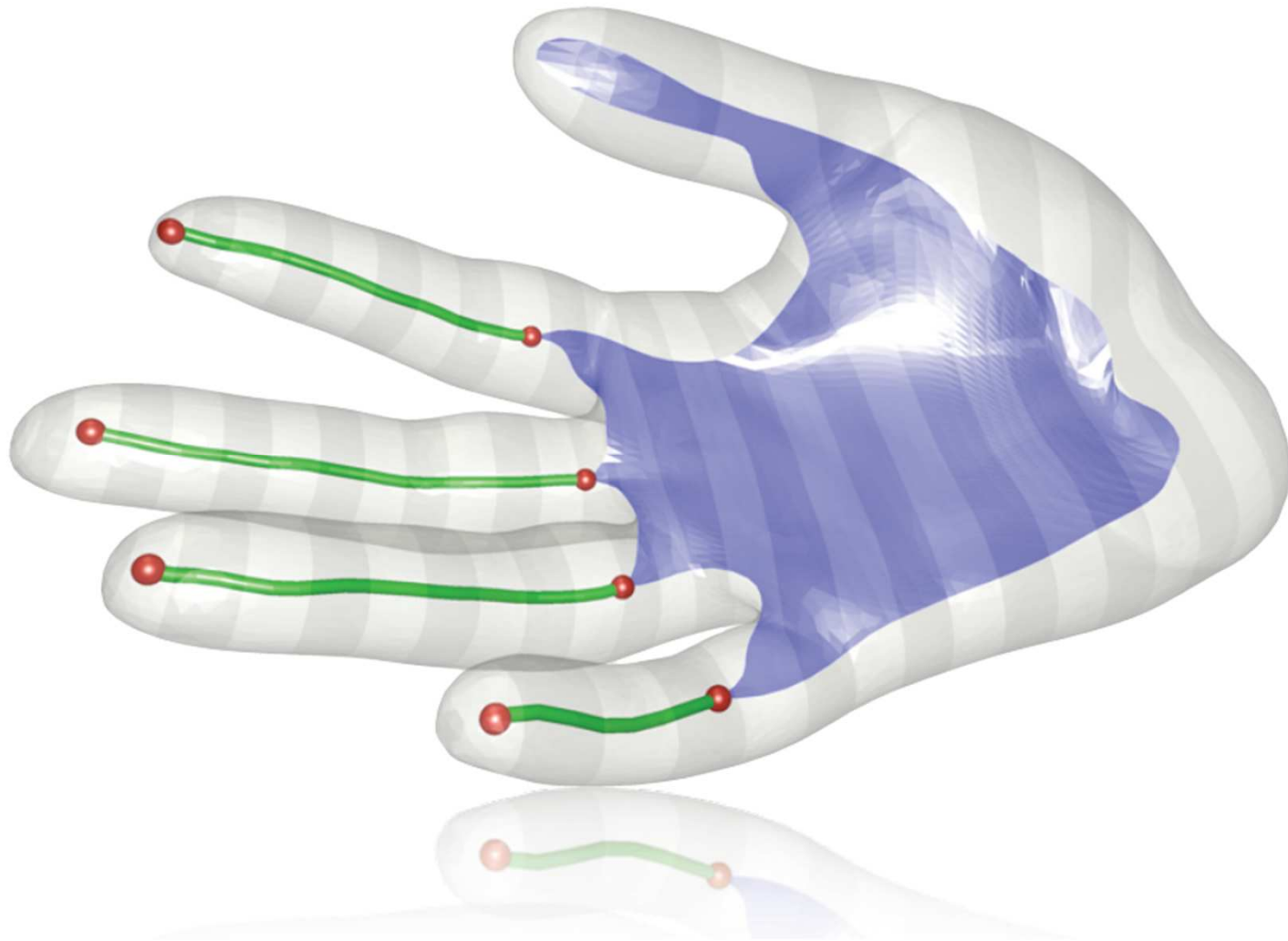
1D Skeleton



Either 1D or 2D structures require manual effort for down-stream applications
Intrinsic to the object (no user interaction except for setting parameters)
Often no consistent topology

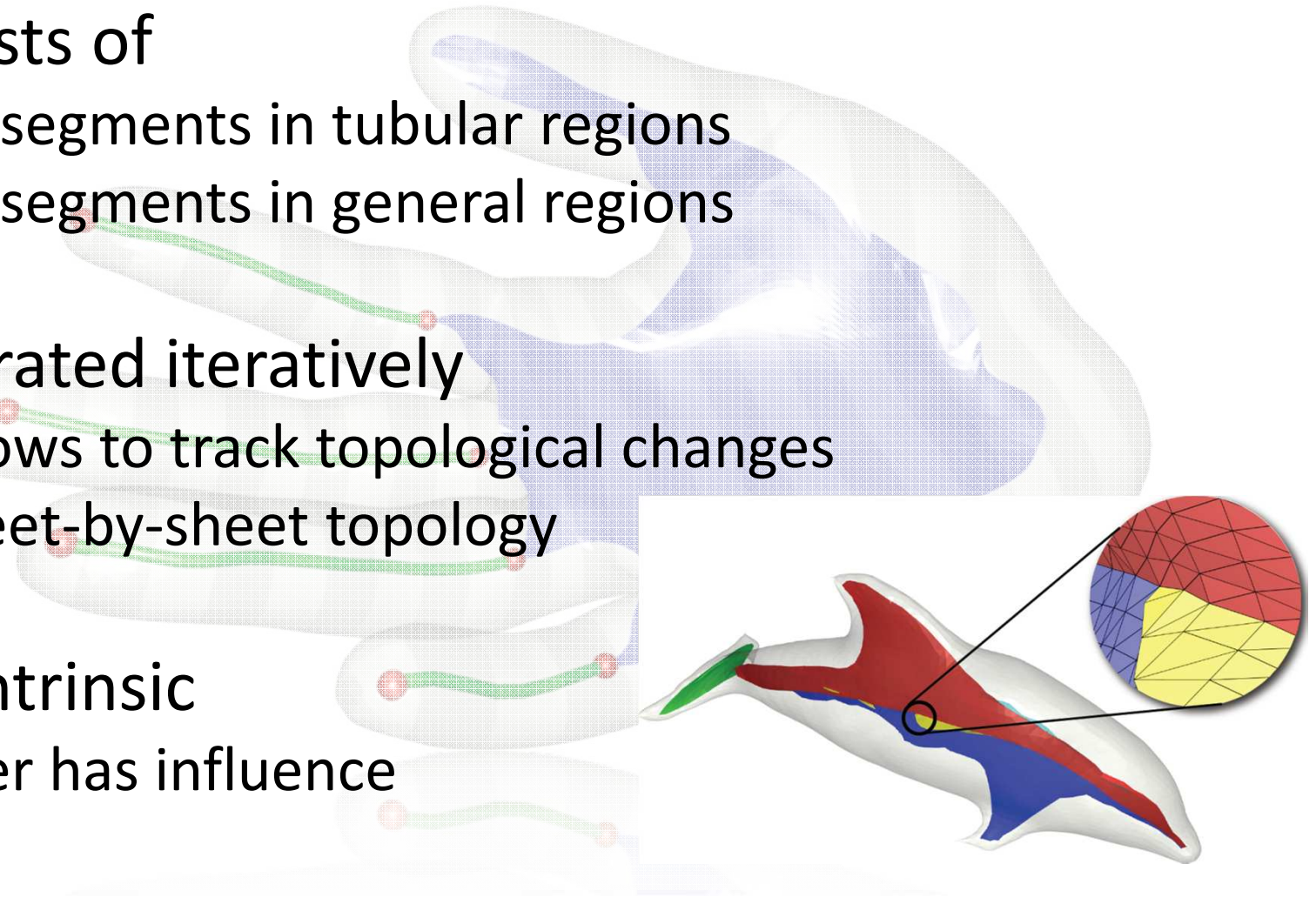


Generalized Swept Mid-Structure (GSM)



Generalized Swept Mid-Structure (GSM)

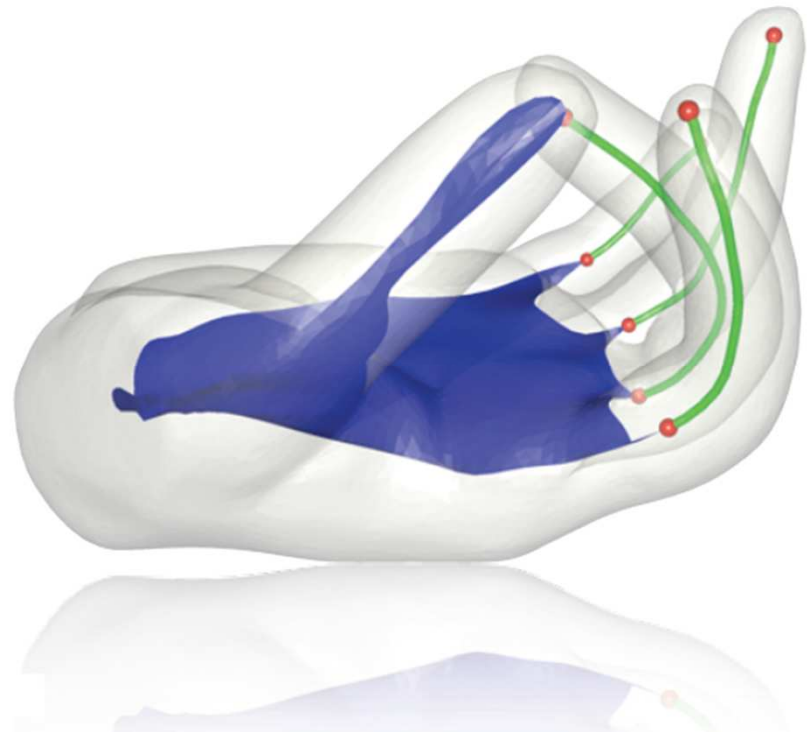
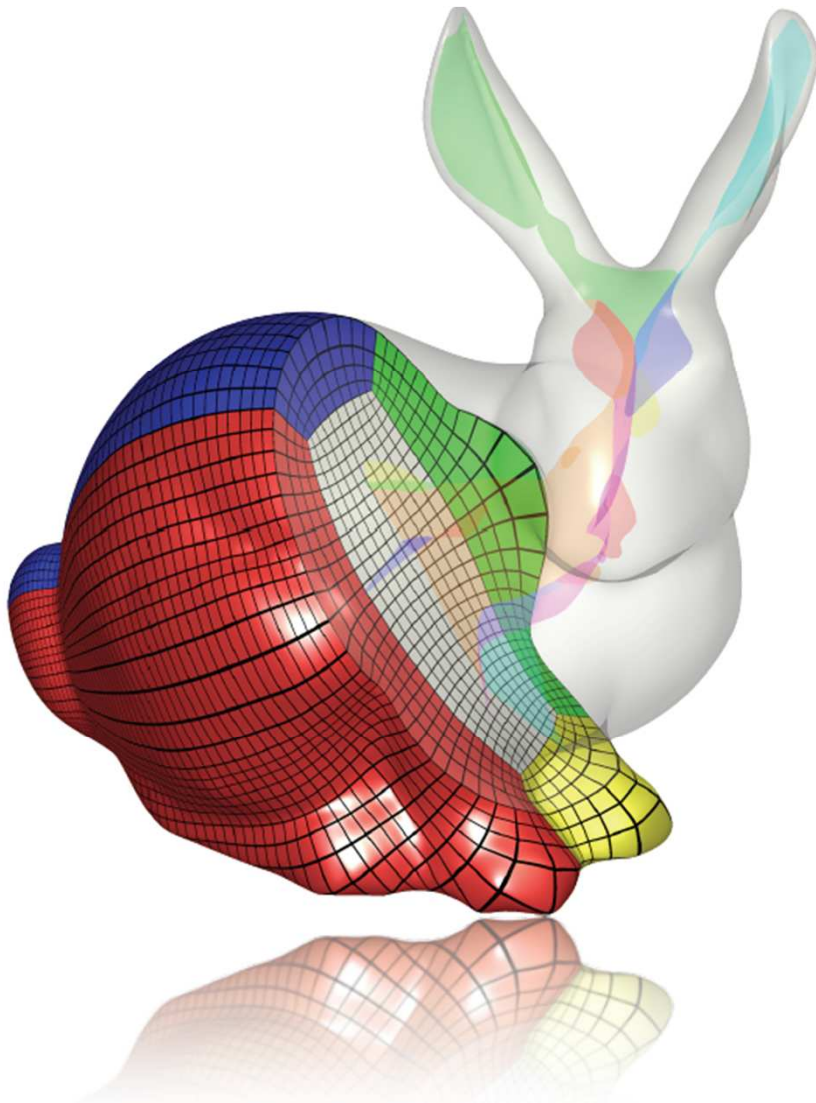
- Consists of
 - 1D segments in tubular regions
 - 2D segments in general regions
- Generated iteratively
 - Allows to track topological changes
 - Sheet-by-sheet topology
- Not intrinsic
 - User has influence



GSM Pipeline

Show video

Applications of GSM



Acknowledge

- Part of the materials of this lecture is provided by
 - Diego Nehab
 - Tobias Martin