

Computer Graphics and Applications

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What is Computer Graphics?

- Modeling
- Rendering
- Animation
- Simulation
- Interaction



Where is it used?

- Entertainment
- Industrial design
- Cultural heritage
- Education
- Bio-medicine
- ...



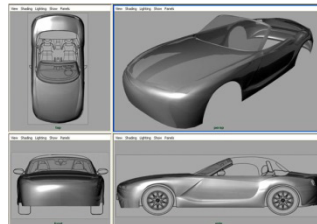
"Avatar"



"Starcraft"



"Storytelling Alice"



Car design



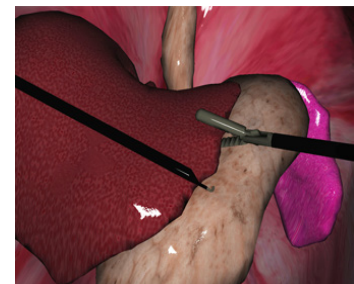
Interior design



Visualization



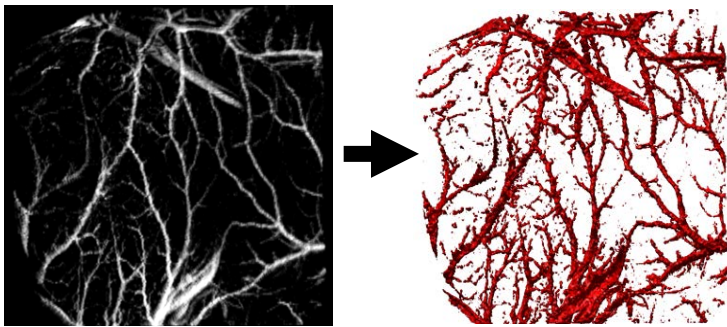
"Rome Reborn"



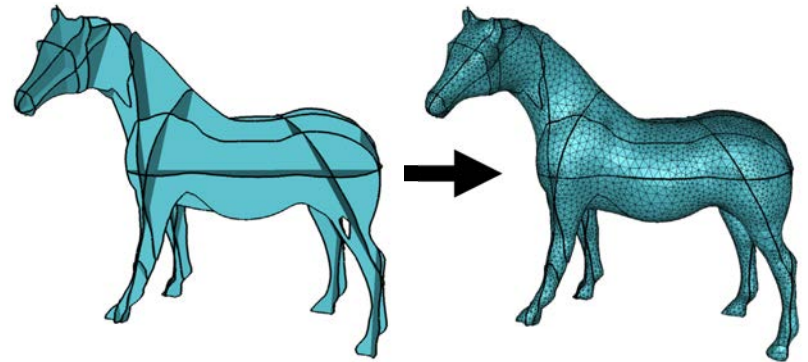
Virtual surgery

Modeling

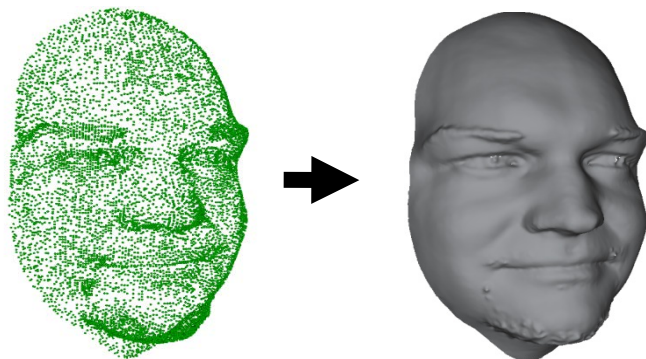
- Modeling from real-world data



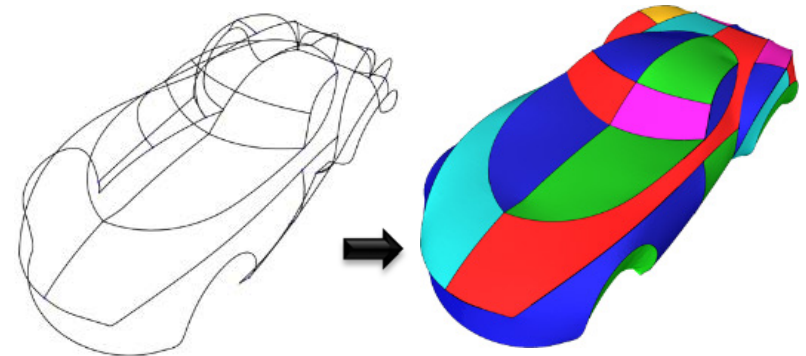
From 3D volumes (e.g., MRI/CT)



From cross-sections



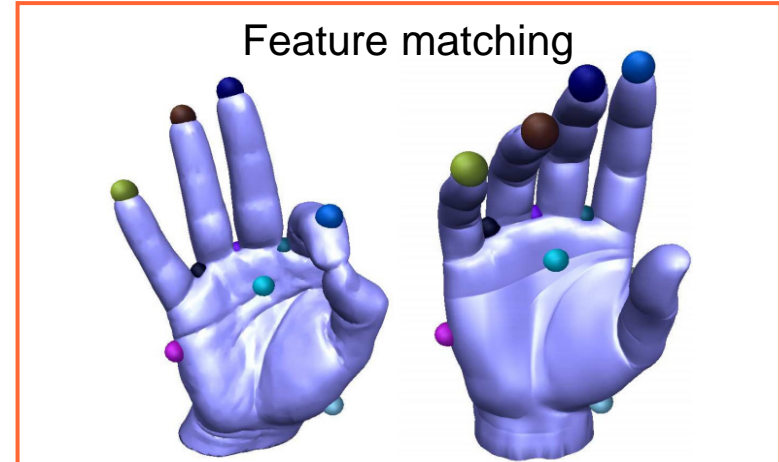
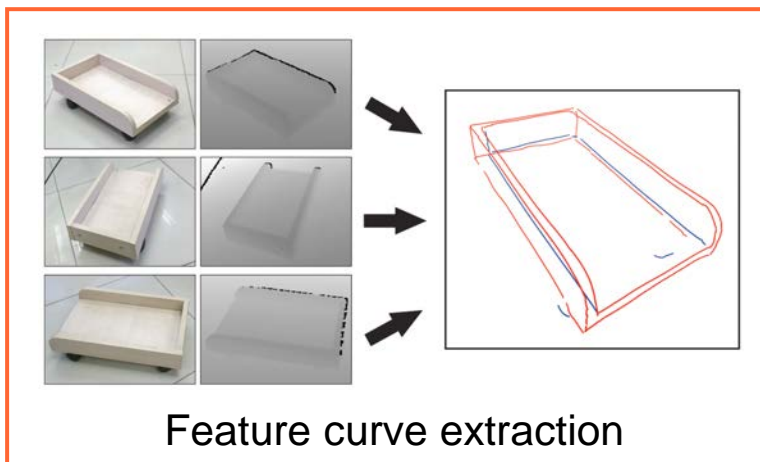
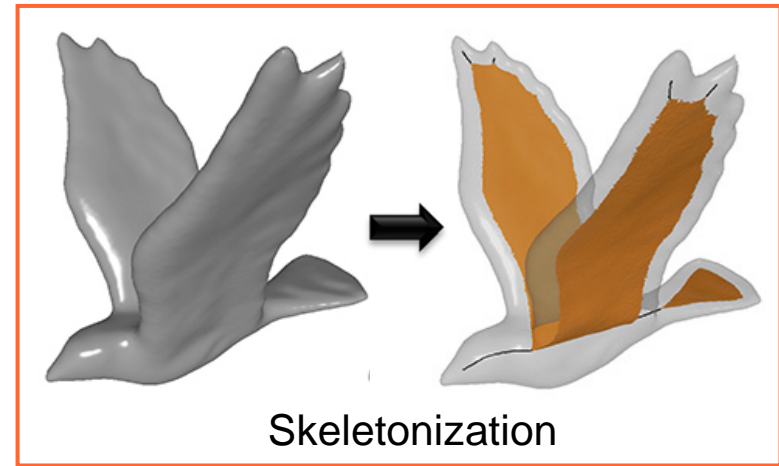
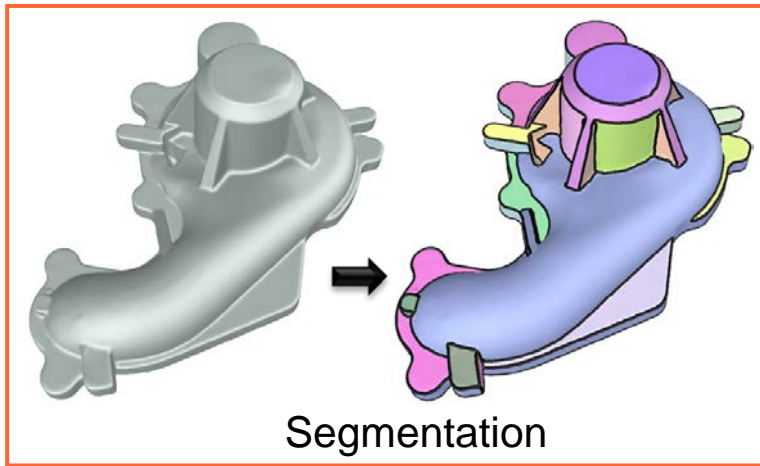
From point cloud



From curve networks

Modeling

- Shape analysis



Modeling

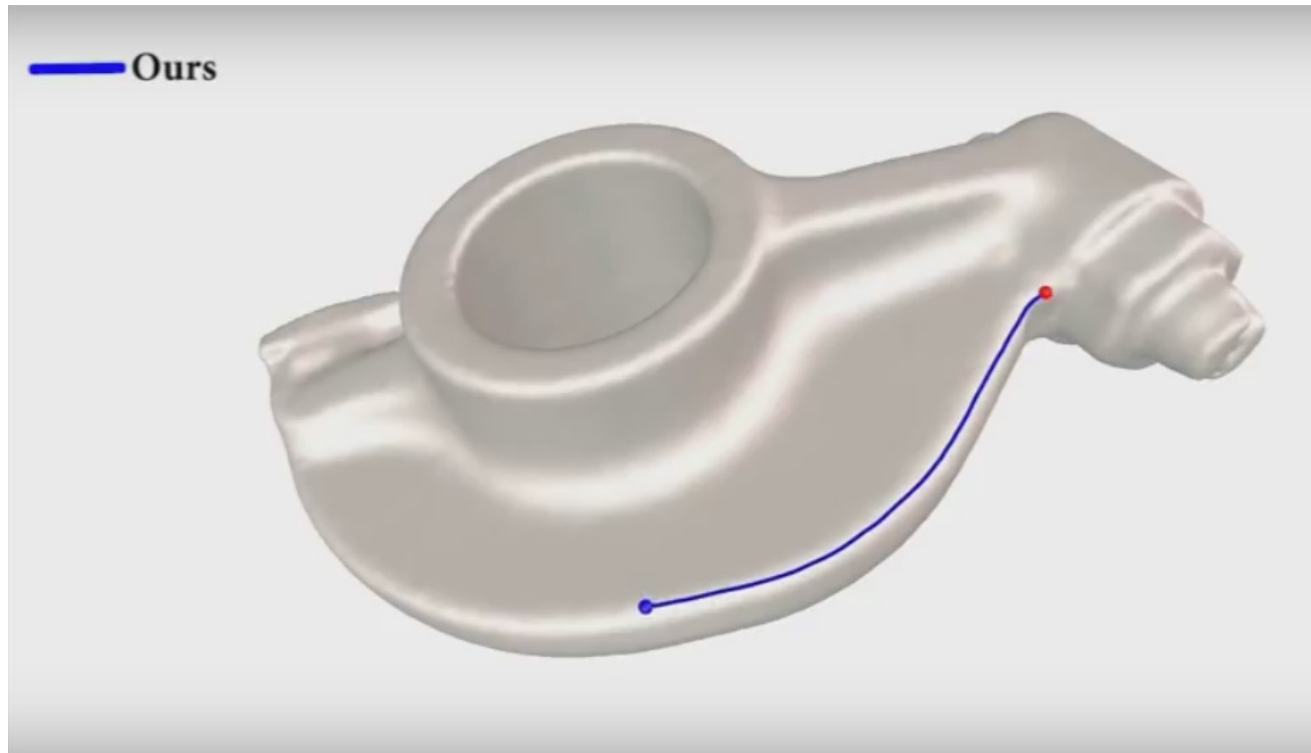
- Interactive modeling from images



Modeling a chair

Modeling

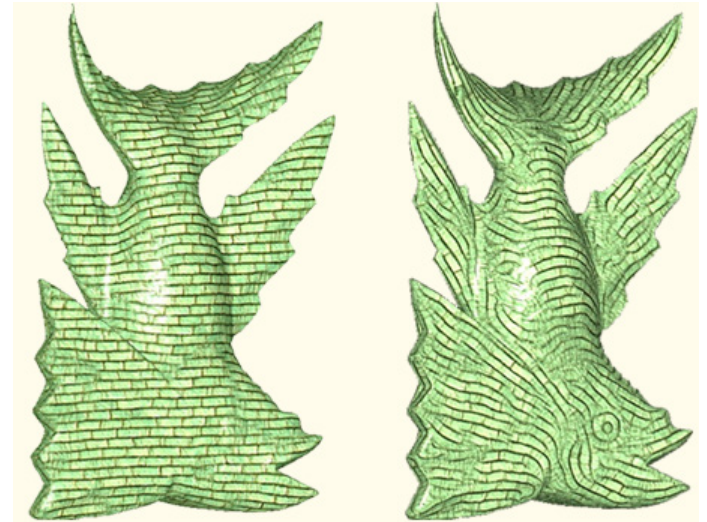
- Interactive shape analysis



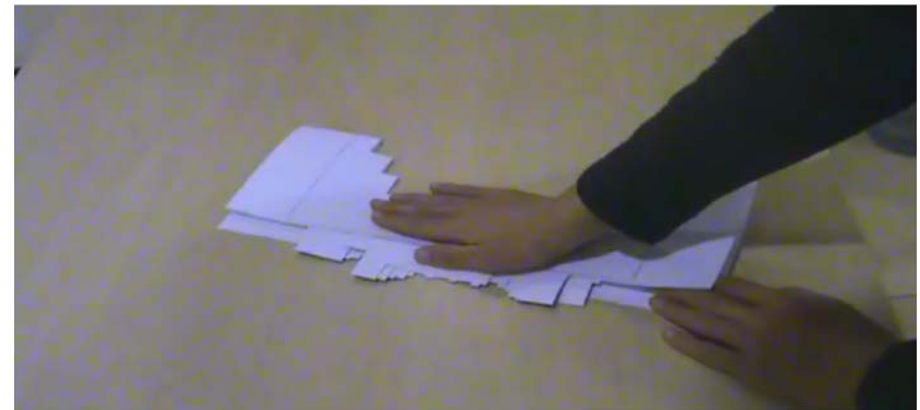
Modeling



Stylizing images



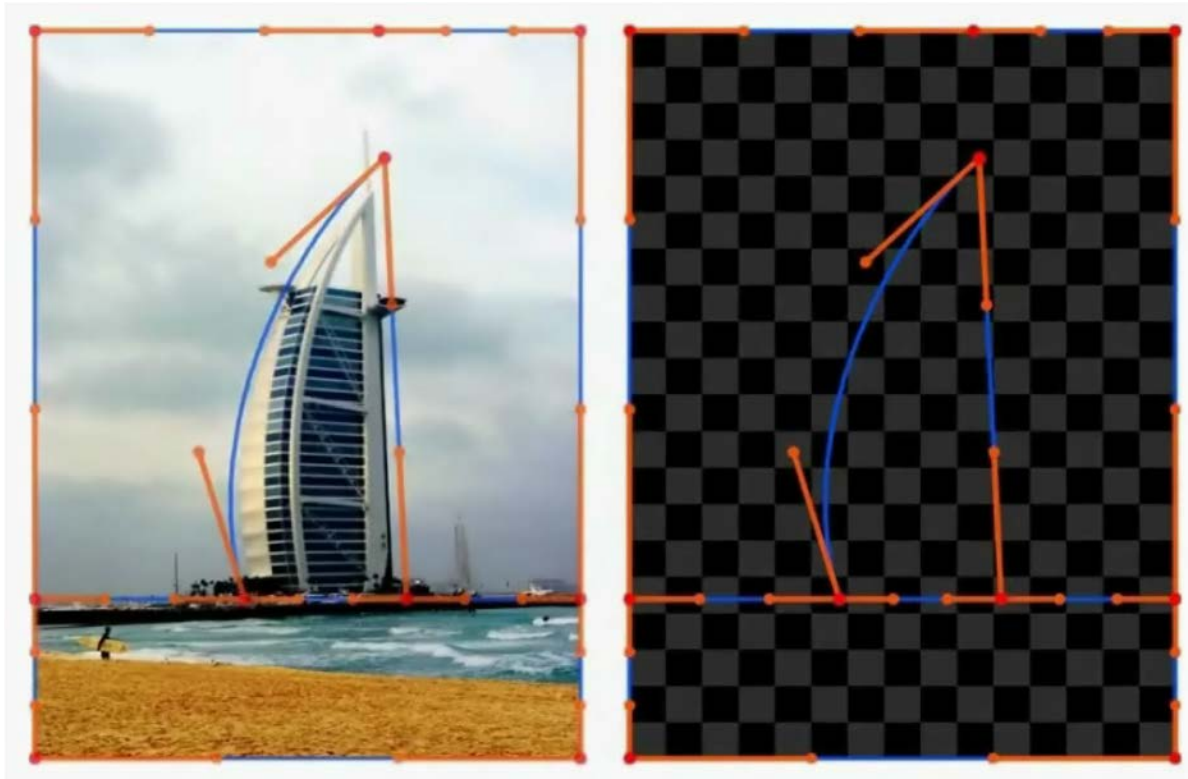
Texturing surfaces



Making pop-up cards

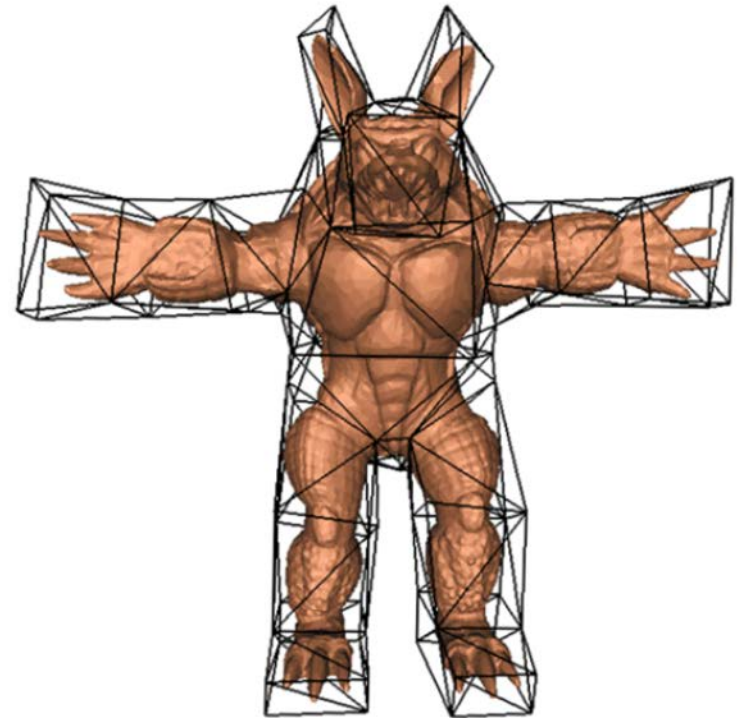
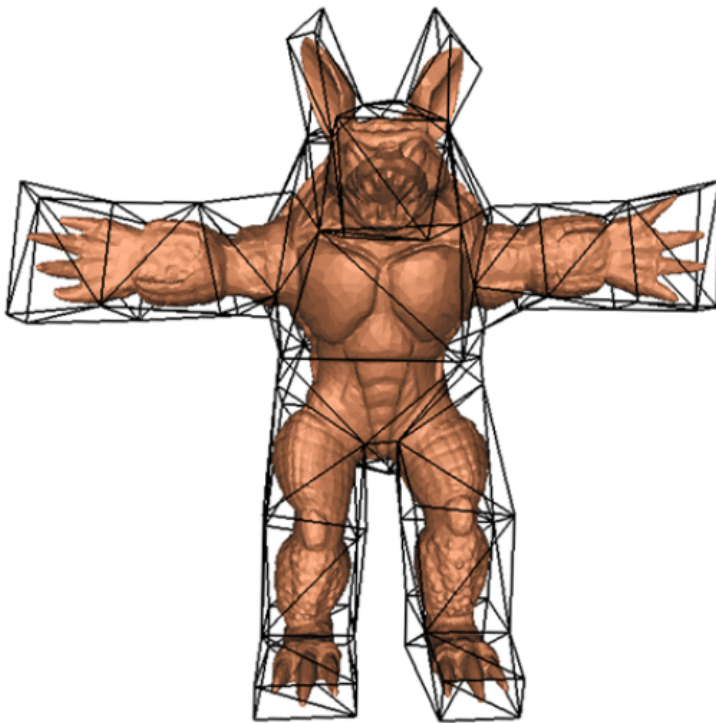
Animation

- 2D cage-based image deformation



Animation

- 3D cage-based character animation



Model at a resting pose and its cage (black lines)

Moving the cage deforms the model

Animation

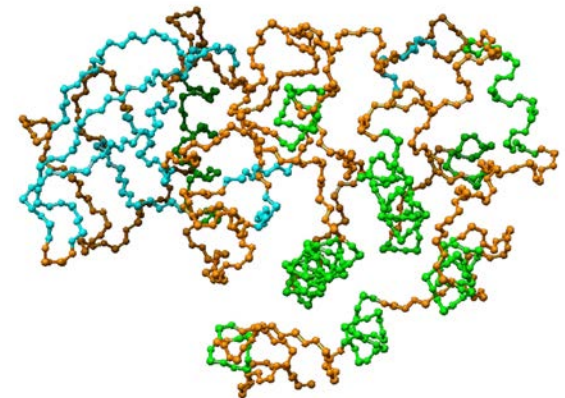
- 3D cage-based character animation



Bio App: Structural Biology

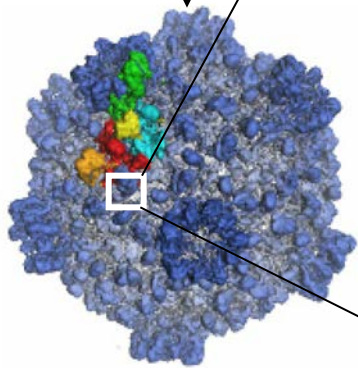
- Study of 3D protein structures
 - Protein: a sequence of amino acids folded into a unique 3D shape
 - One protein may exhibit different shapes in different environments
 - Protein function derived from its structure
 - Key to understanding biological processes and developing drugs

SSVFVPDEWEVSREKITLLRELGGSGFGM ...

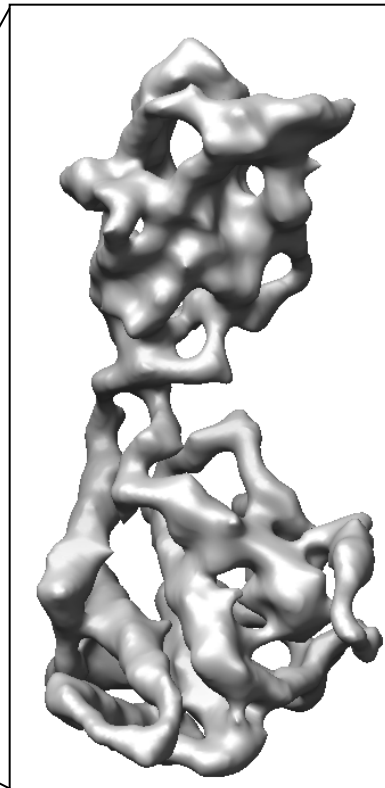


Bio App: Structural Biology

- Cryo-EM imaging of large protein complexes (e.g., virus)



3D image of a virus

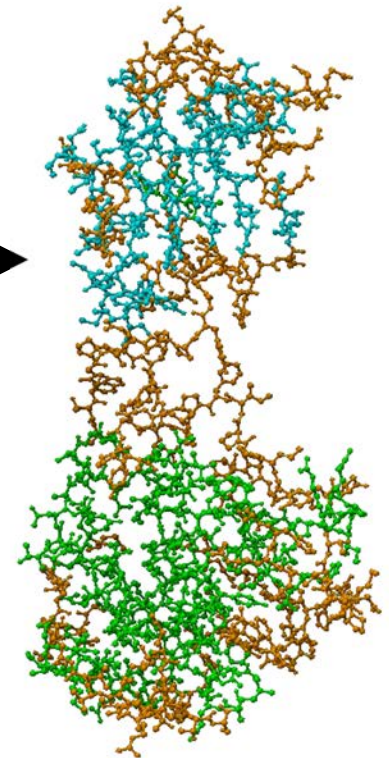


A single protein

?



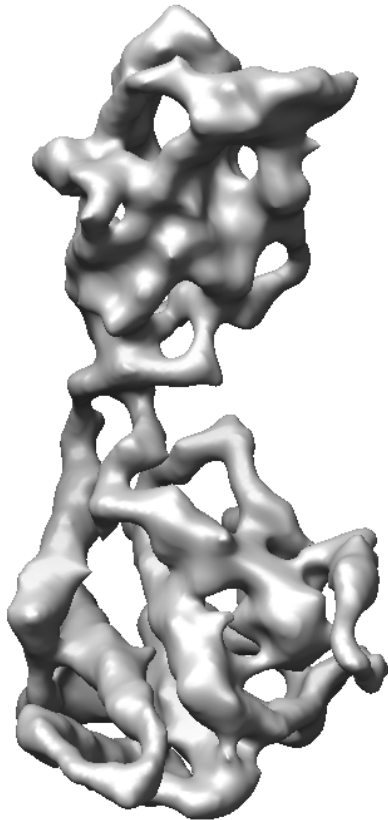
Challenge: building
protein structures
from low-resolution
images



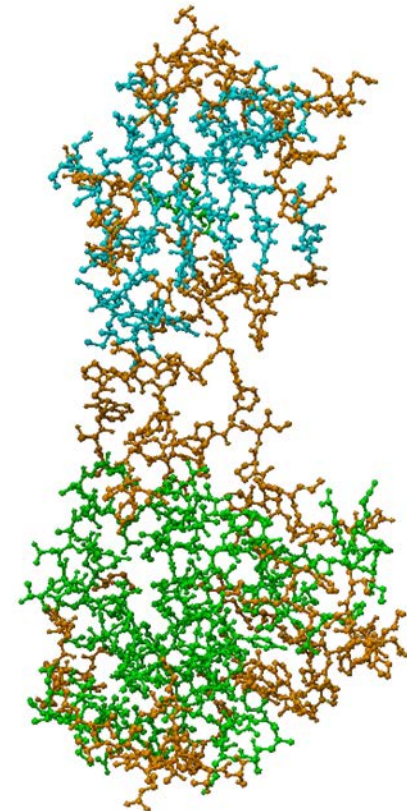
Molecular Structure

Bio App: Structural Biology

- Using shape analysis



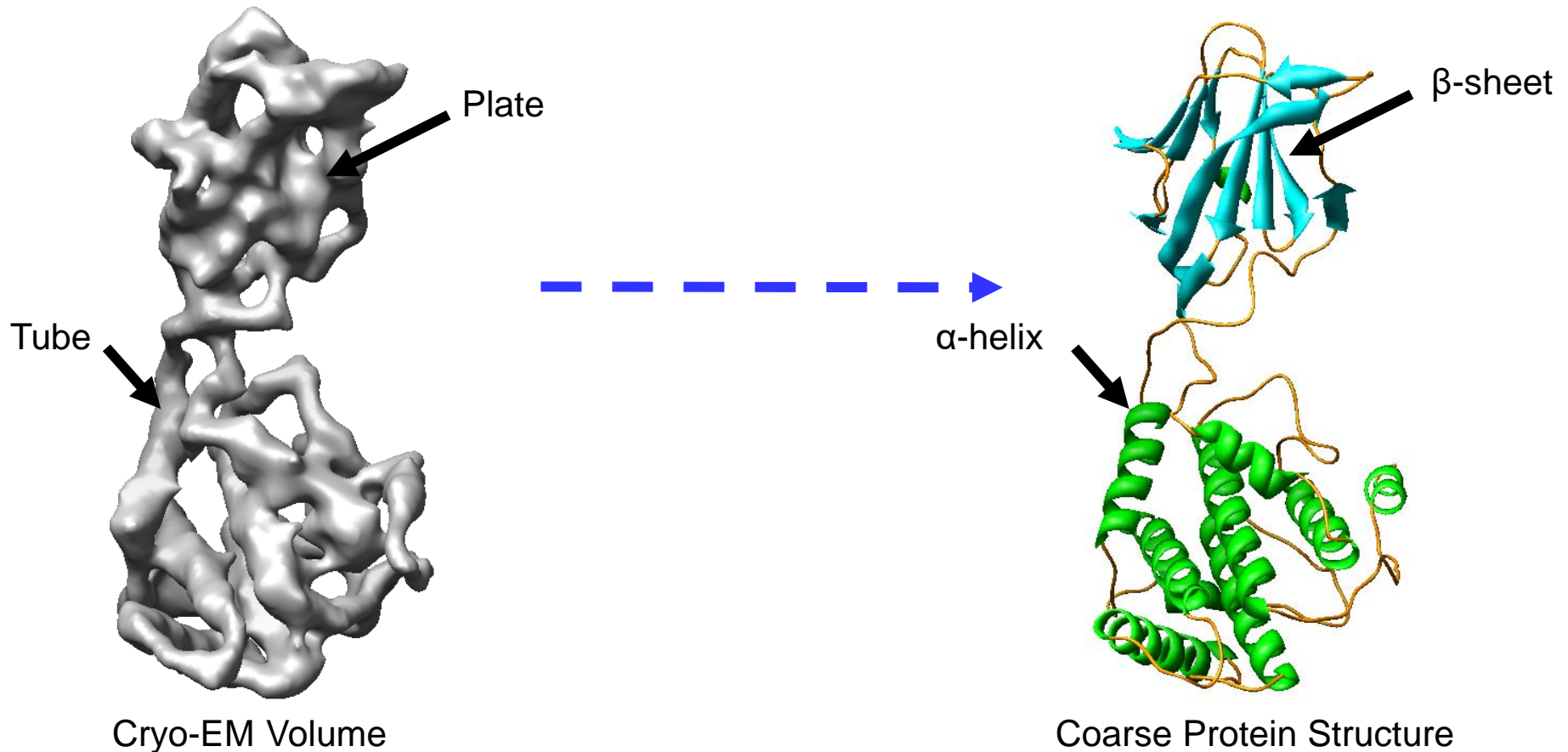
Cryo-EM Volume



Protein Structure

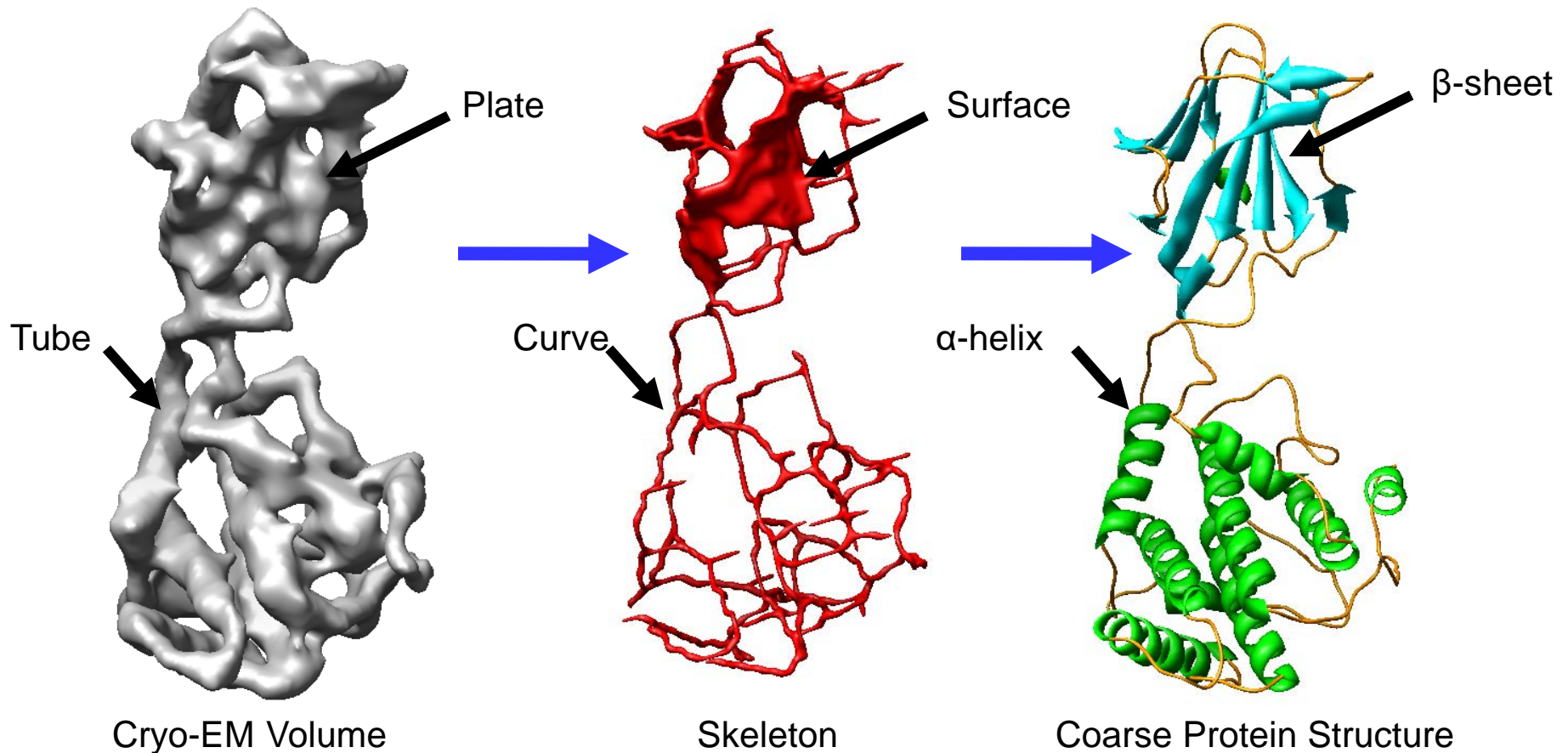
Bio App: Structural Biology

- Using shape analysis



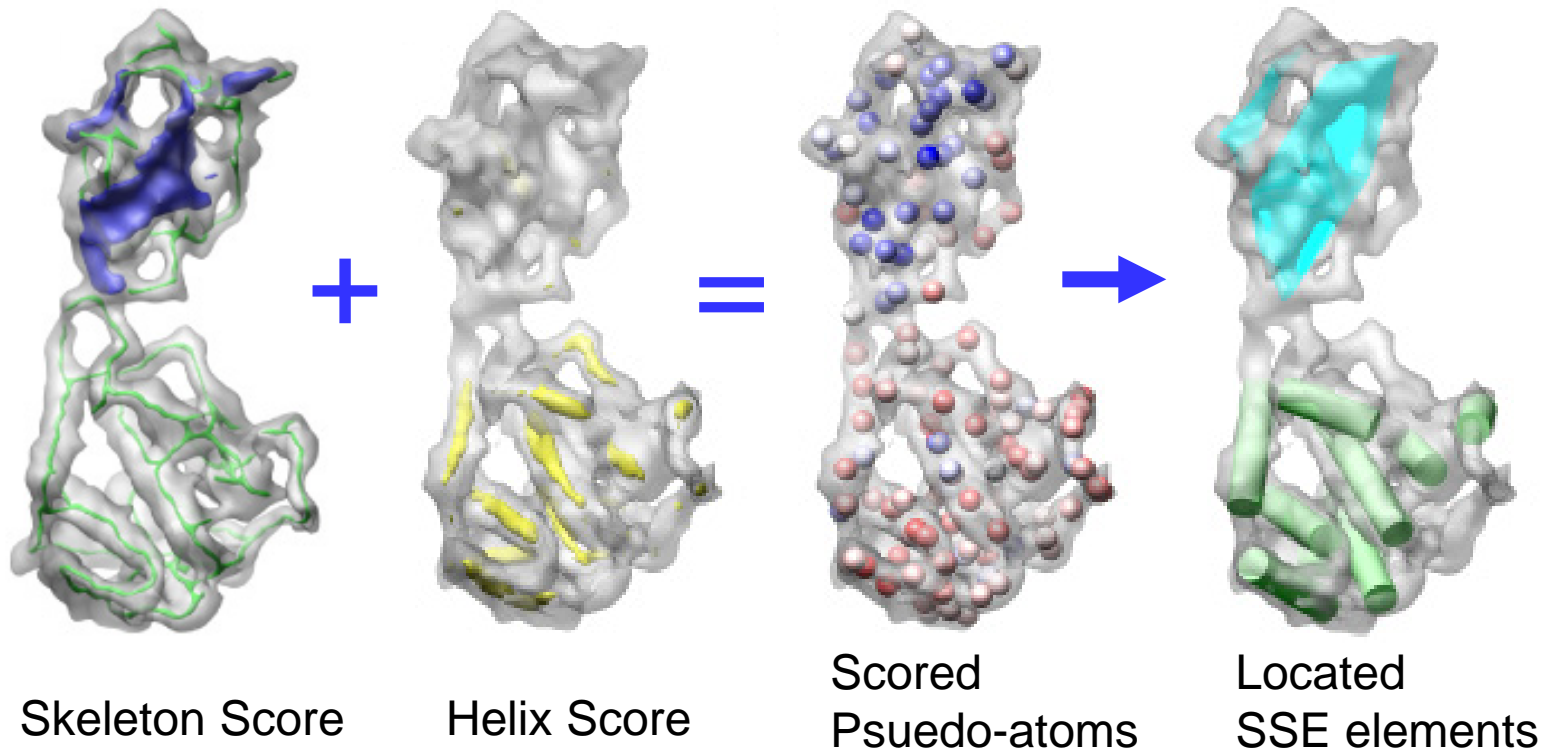
Bio App: Structural Biology

- Using shape analysis



Bio App: Structural Biology

- Skeleton-based detection of secondary structure elements



Bio App: Structural Biology

- Connectivity among helices based on the skeleton
 - Using graph matching with protein primary sequence
 - Current work: connectivity among sheets

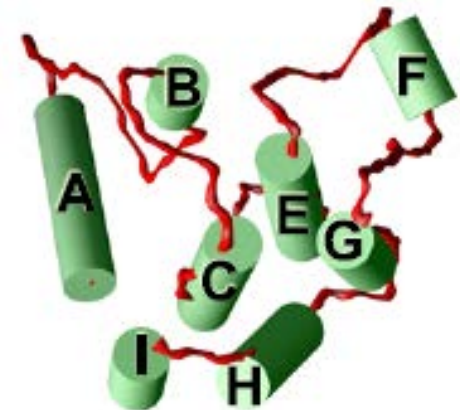
```
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RWAKTVNESAS A WGFCHHNYLLGWVSKGQ  
PTLYVMELWAHGD B LRPEAENIPG C  
D KFAHRDLAARNCMVAHDFVWGGDFGMTRDIYETD  
IYRWGGKGLLPVRWMAF D VFTT E VESF  
F AEQFYQGLSN F GGYLDGQDMCP G  
QFNPKNRPTF H DDLHPSF I FFHSEENK
```

Protein sequence
with helix annotation

+



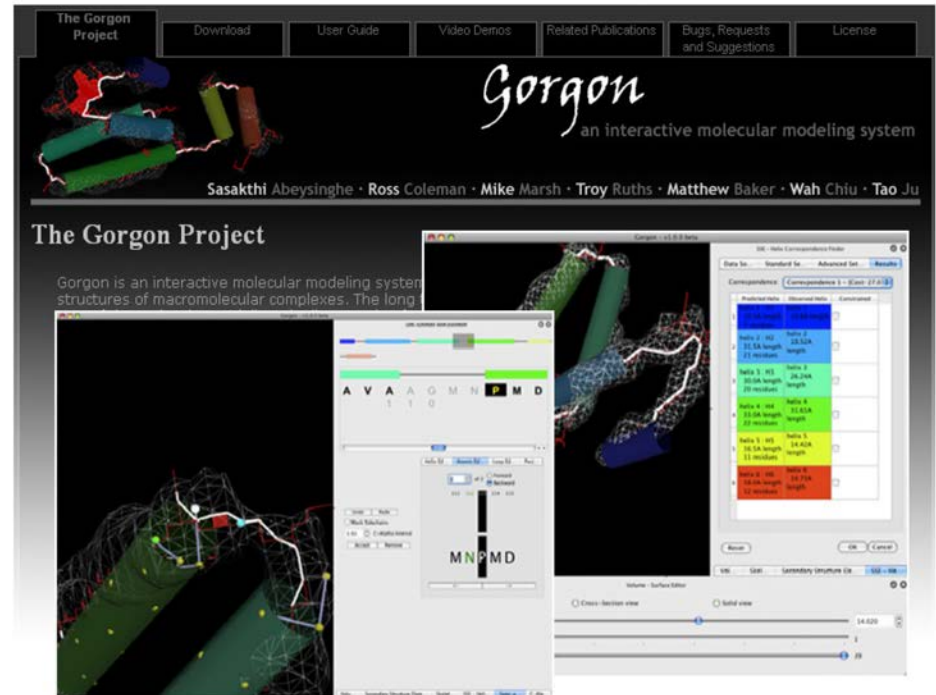
Cryo-EM skeleton
with identified helices



Connected helices

Bio App: Structural Biology

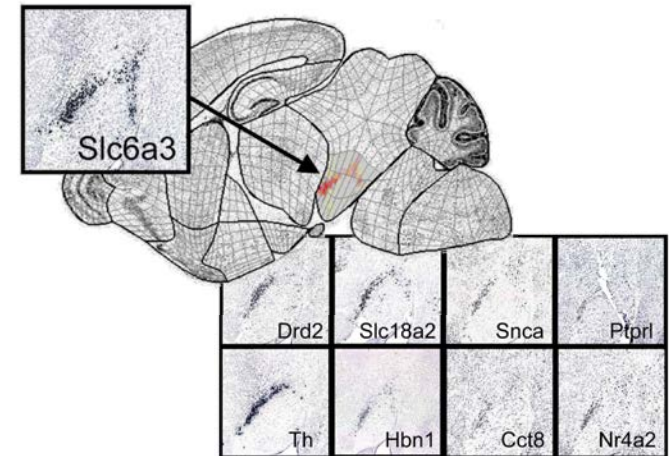
- *Gorgon*
 - Interactive protein modeling tool for low-resolution density maps
 - Co-developed by WashU and Baylor College of Medicine
 - 500+ registered users in 40+ countries, 3 training workshops in Houston



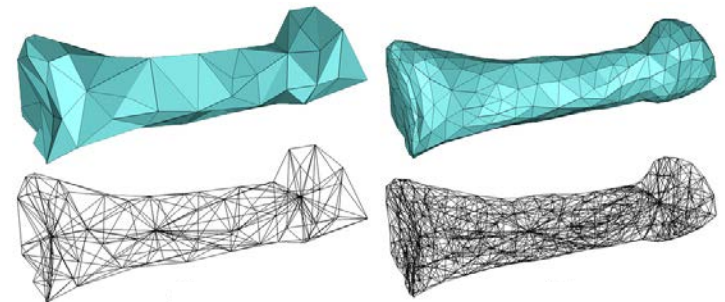
<http://gorgon.wustl.edu> (Google: "Gorgon")

Bio App: Others

- Neuroscience
 - Comparing expression patterns of different genes in the mouse brain using geometric model of the brain



- Radiology
 - Monitoring bone shape and density changes using geometric models of the foot bones



Graphics Courses @ WU

- CSE 452: *Computer Graphics*
 - Basics in image processing, modeling and rendering
 - Prerequisite: 247, 332
- CSE 554: *Geometric computing for bio-medicine*
 - Algorithms in geometric modeling with bio-medical examples
 - Prerequisite: 247, 332 (452 recommended)
- CSE 546: *Computational Geometry*
 - Data structure and algorithms for spatial data
 - Prerequisite: 247 (347 recommended)

