# Visualization and Nonphotorealistic Rendering

Adrien Treuille
Carnegie Mellon Universtiy

# Outline

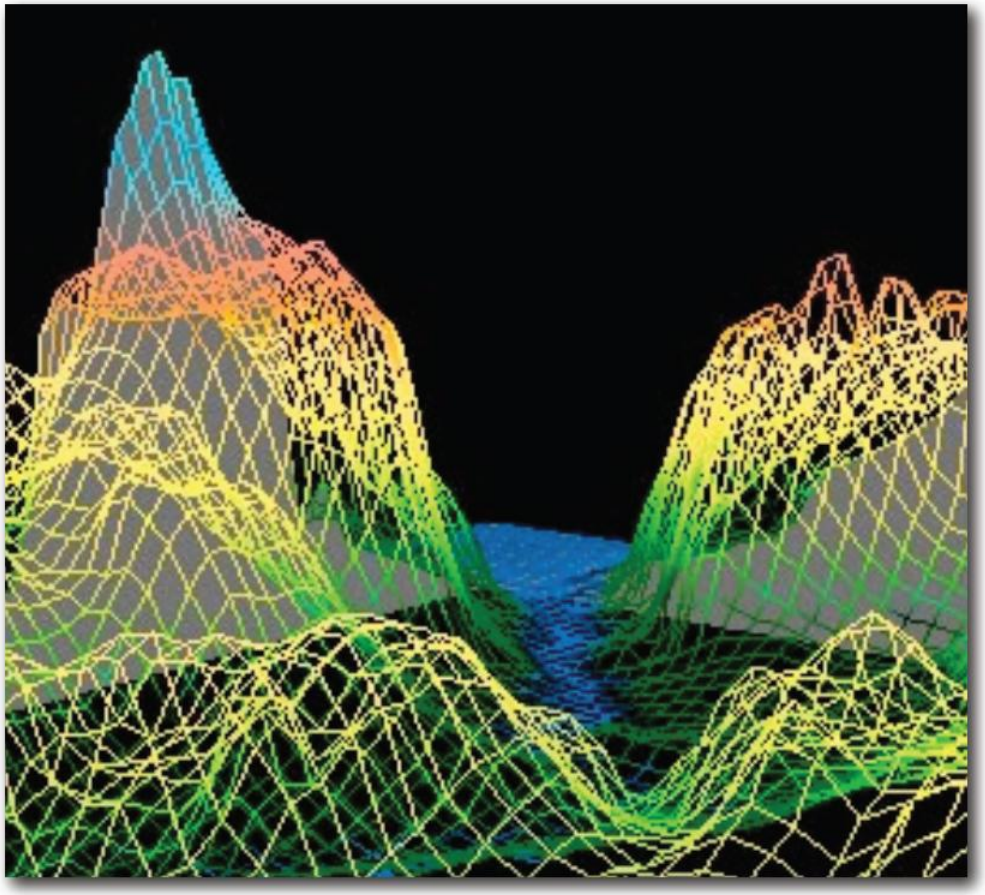
- Visualization
- Non-photorealistic Rendering
- Cutaway Illustration
- Contour Drawing
- Good photographs.
- Map Drawing

# Visualization

http://medvis.vrvis.at/fileadmin/hvr/images/headlarge.jpg

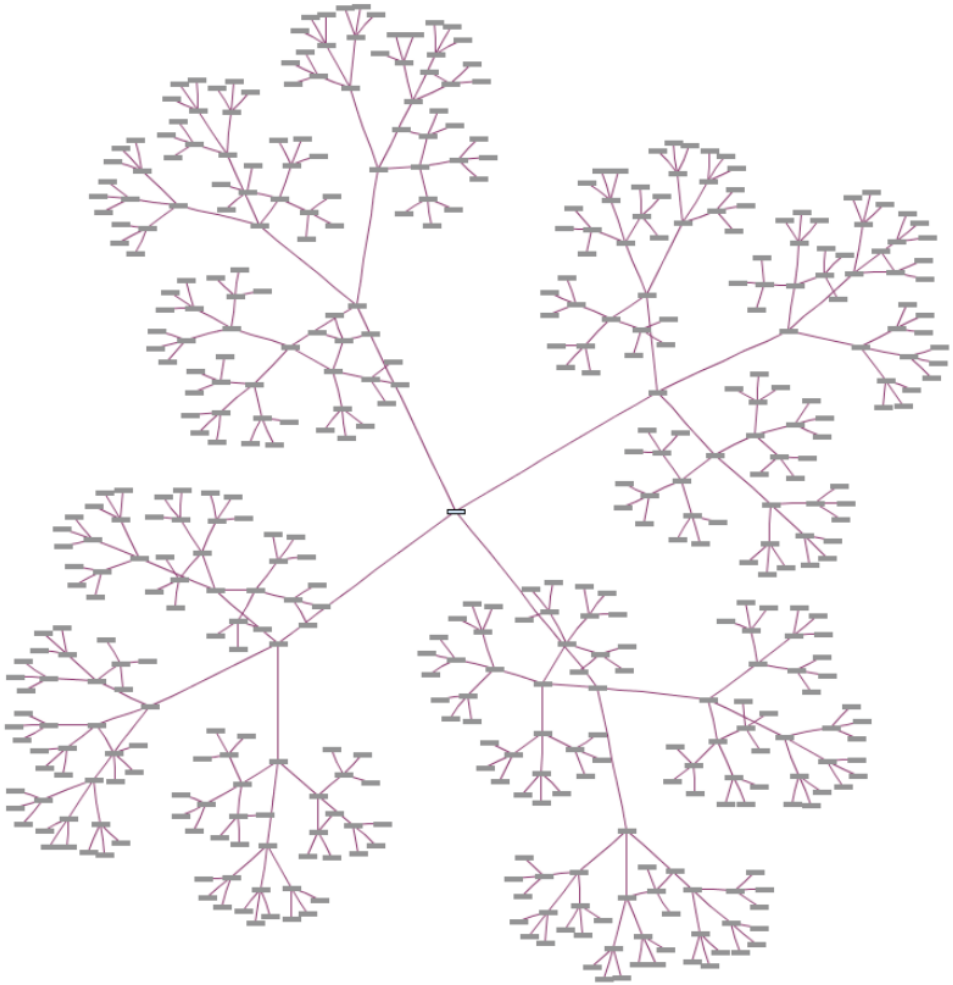
- Goal: Use computer graphics to understand data.
- For virtual every data type there is a corresponding visualization.
  - The importance of graphics!

# Numerical Data



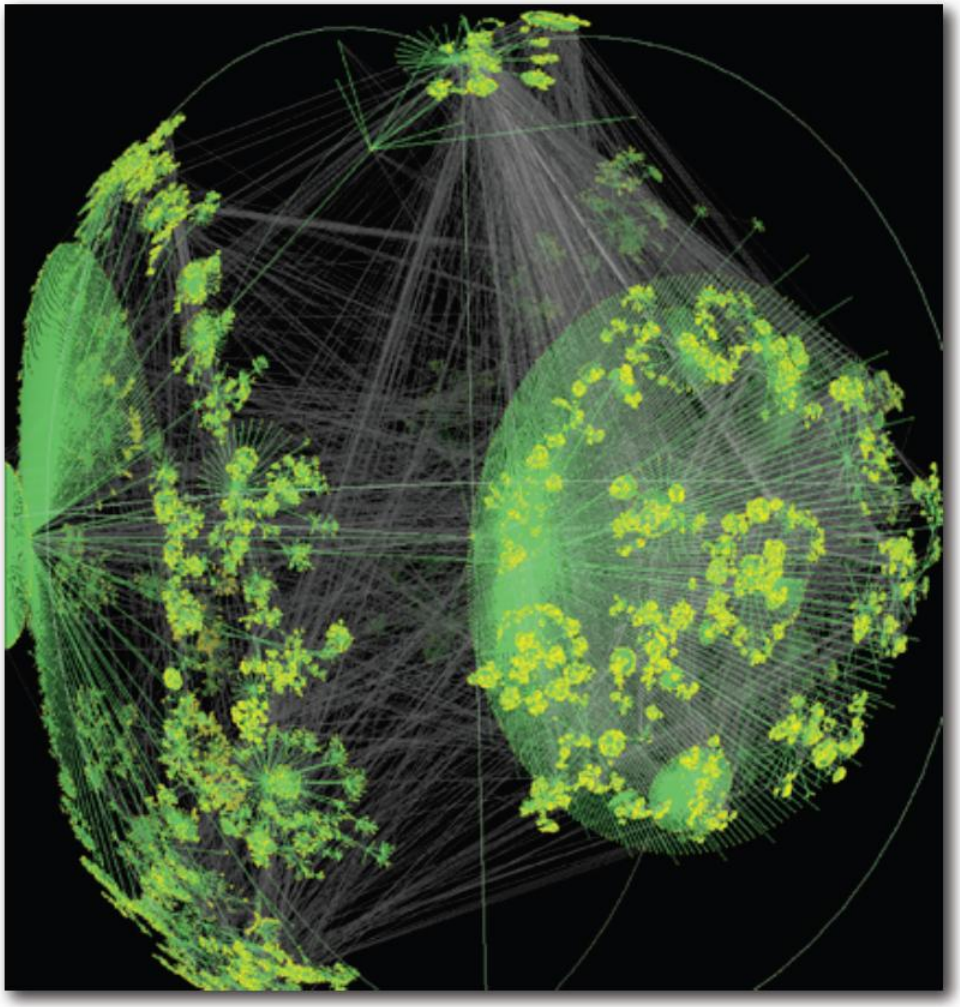
http://www.manifold.net/news/fly_through.jpg

# Graphs



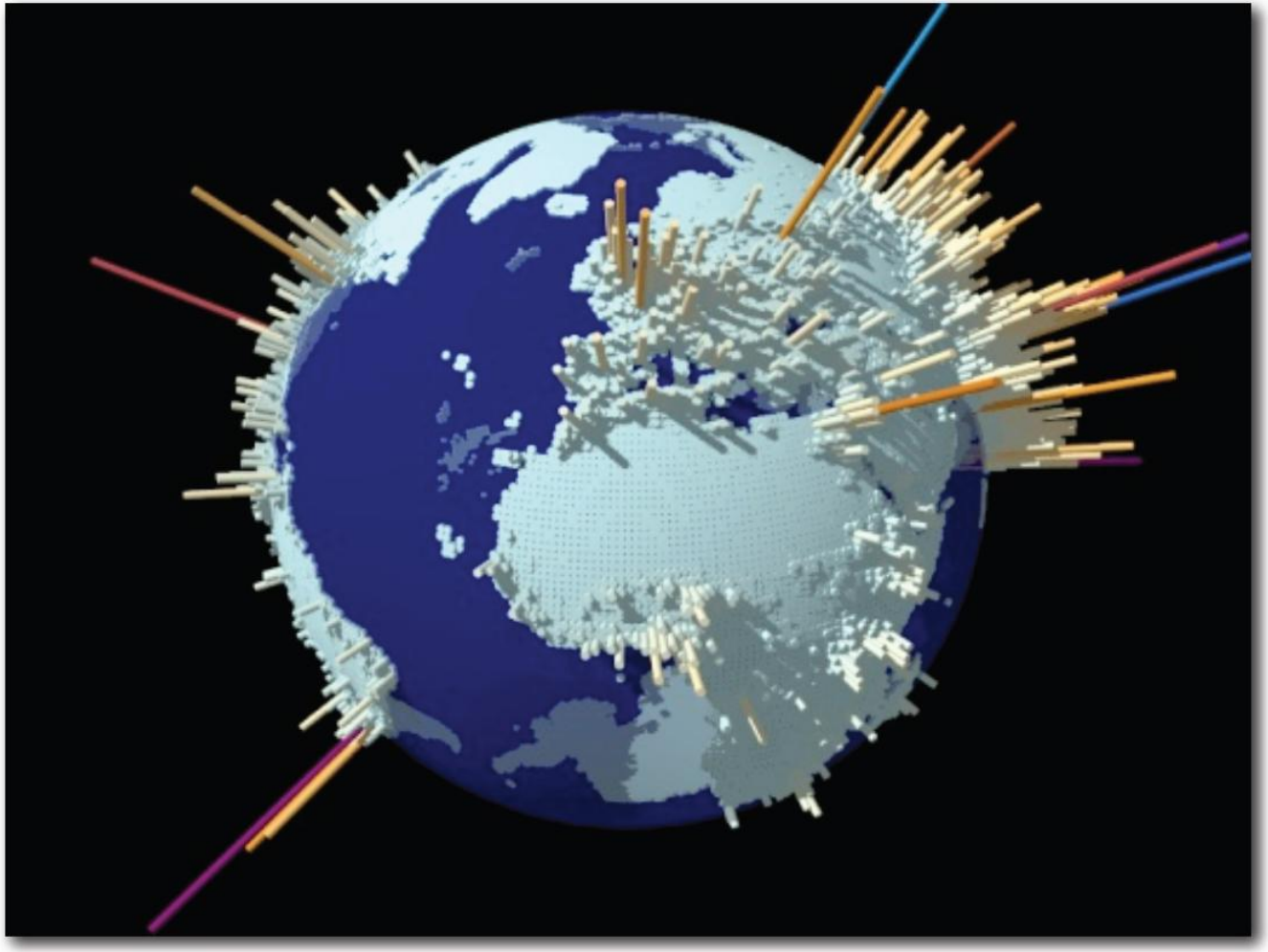
http://www.wandora.org/wandora/wiki/images/Tree_graph_example.gif

# Graphs



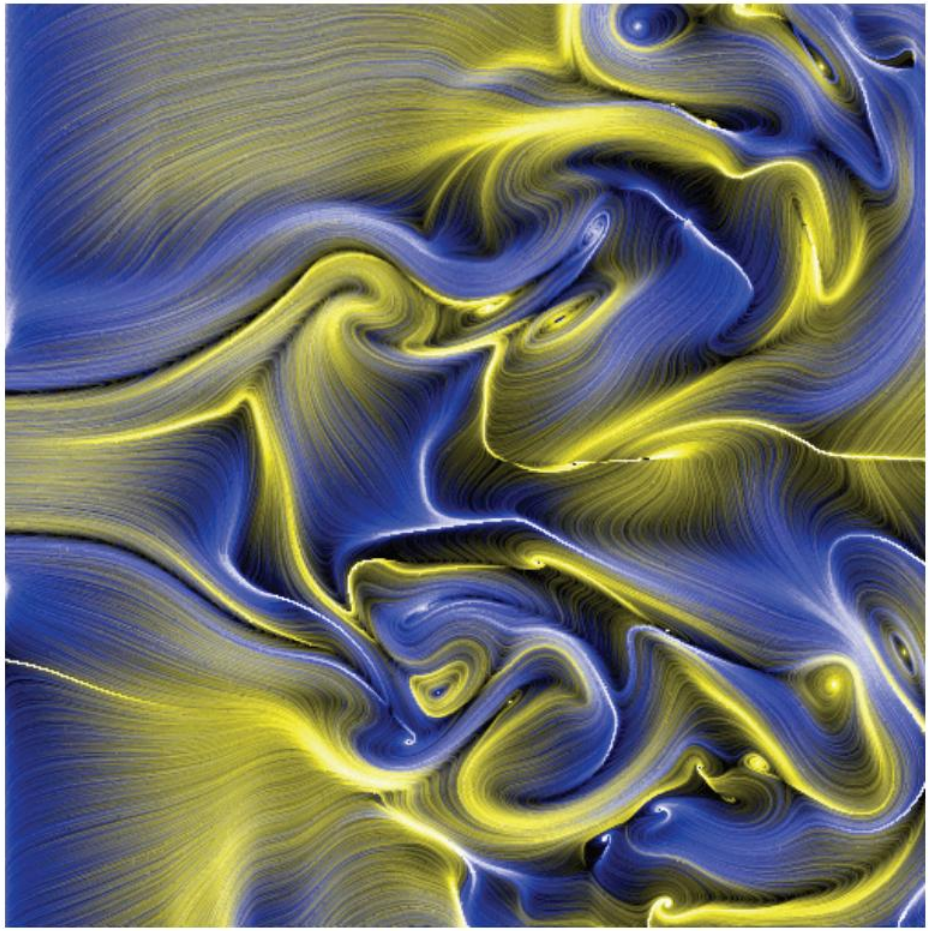
http://www.designinginteractions.com/chapters/7

# Geographic Data



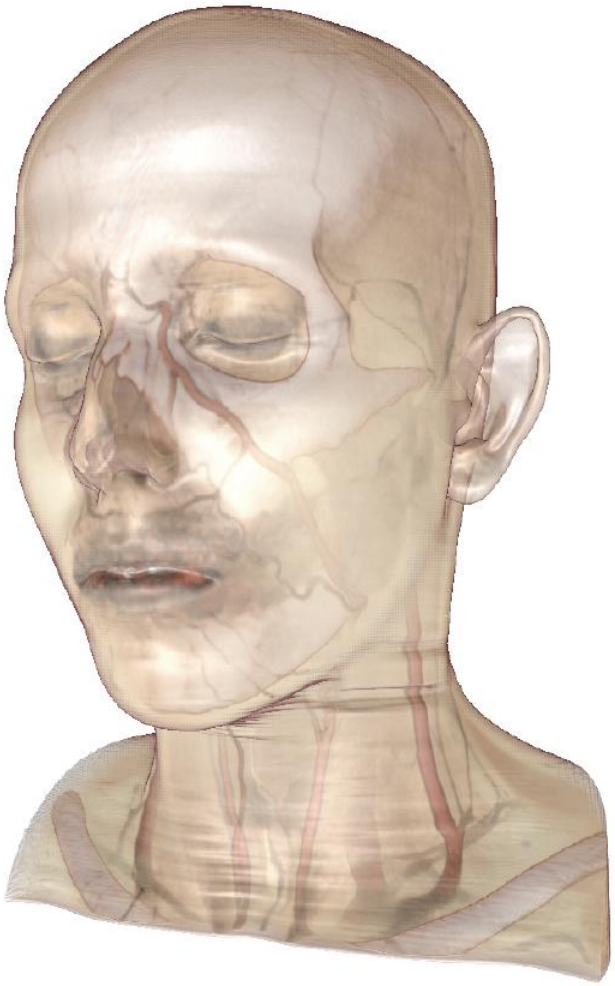
http://flowingdata.com/wp-content/plugins/yet-another-photoblog/cache/g_econ.6zhzwniskpgcwwgs00okoco4s.7dm680981og04ocskgcsckco4.th.jpeg

# Flow Visualization



http://www.faculty.iu-bremen.de/llinsen/publications/ParkYuHotzKreylosLinsenHamann06.jpg

# 3D Volume Data



http://medvis.vrvis.at/fileadmin/hvr/images/headlarge.jpg

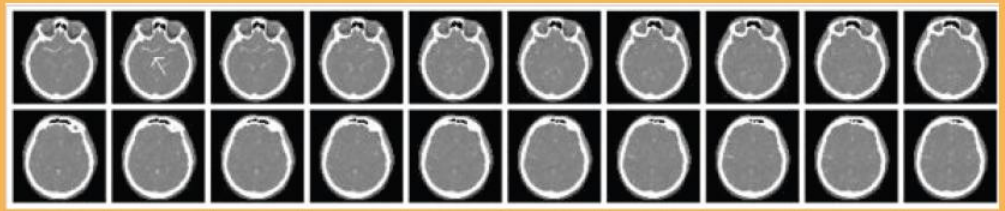
Figure 2.4: An example of a visualization of a single respiratory phase of a 4DCT visualization showing lung, bone, and skin.

[Burak Erem, Thesis]

# Volume Rendering

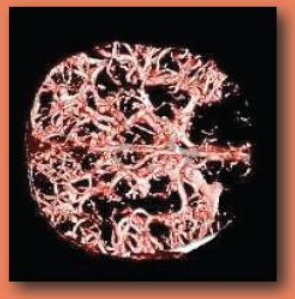
- Visualize Large dataset for scientific / medical application.
- Generally do not start with a 3D model.

INPUT



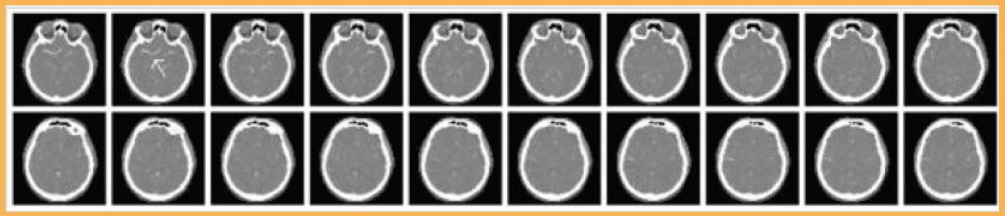
CT Scan - White means higher radiodensity.

OUTPUT



# Large Datasets

INPUT

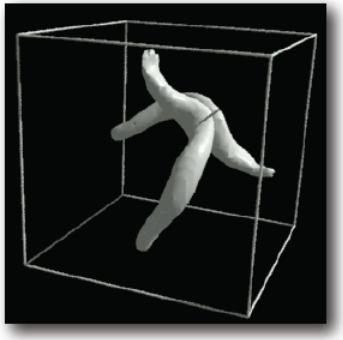


CT Scan - White means higher radiodensity.

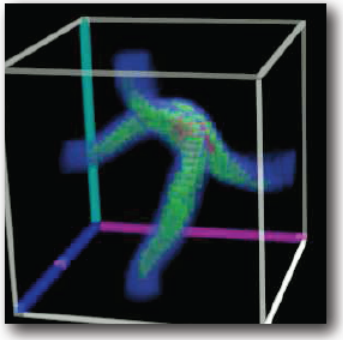
OUTPUT

- CT or MRI:
  - e.g. 512×512×200 ≈ 50MB
- Visible Human:
  - 512×512×1734 ≈ 433MB

# Two Options

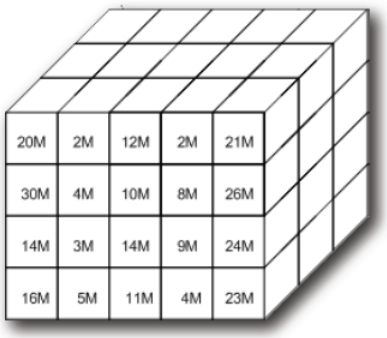


- Surface Rendering



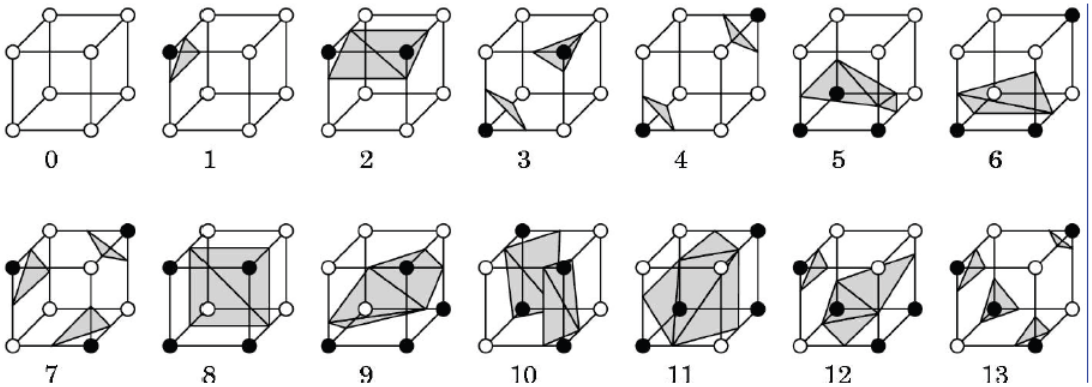
- Volume Rendering

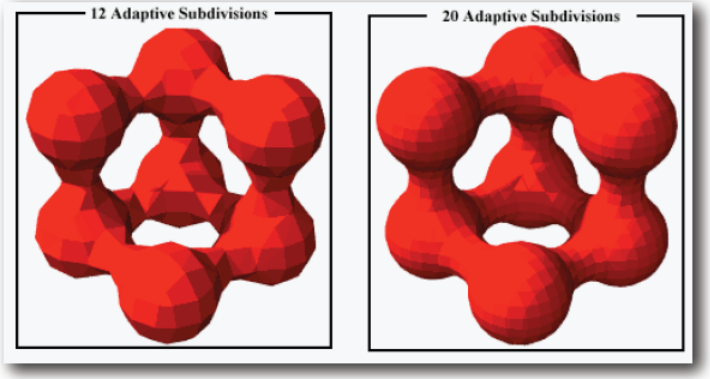
# Surface Rendering




- Threshold volume data.

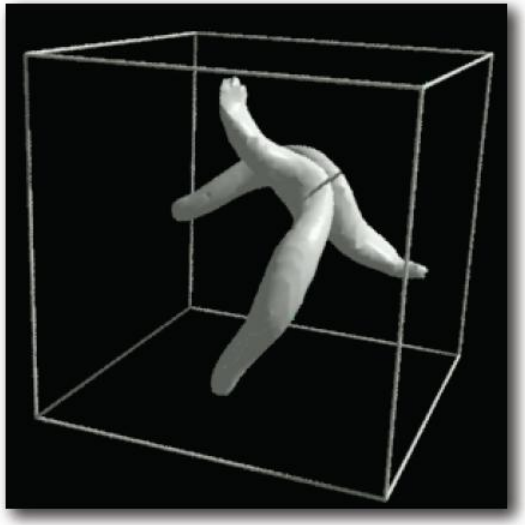
- Then run our favorite algorithm....
- Hint: rhymes with "starching dudes"



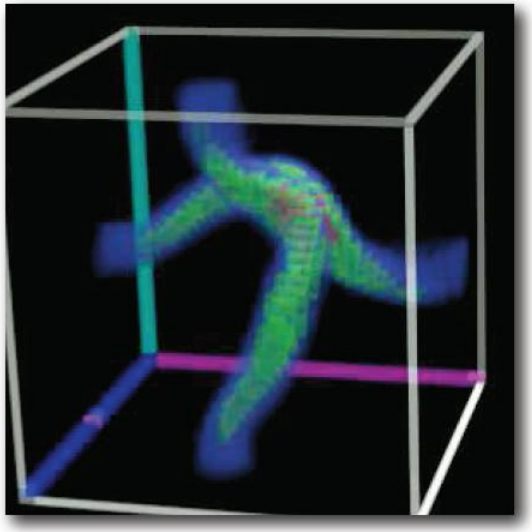



# Volume Rendering

- Some data better visualized as a volume, not a surface.
- Idea: Use voxels and transparency.



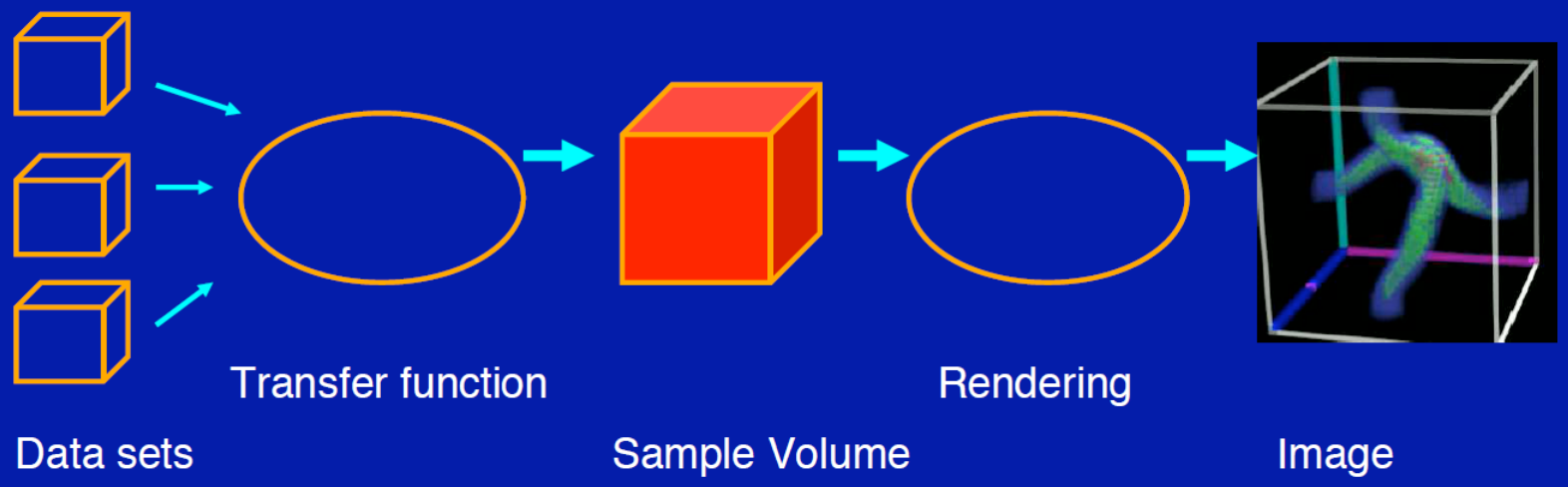
Raytraced Isosurface



Volume Rendering

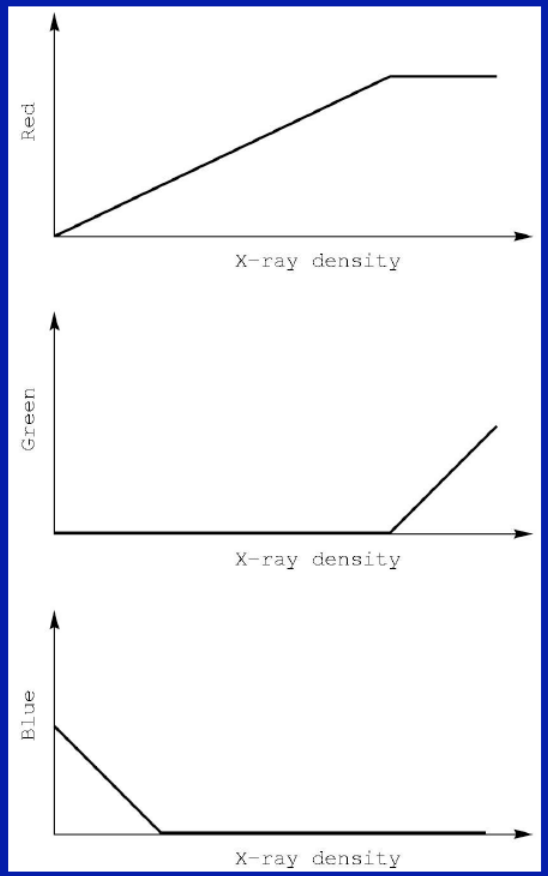
# Volume Rendering Pipeline

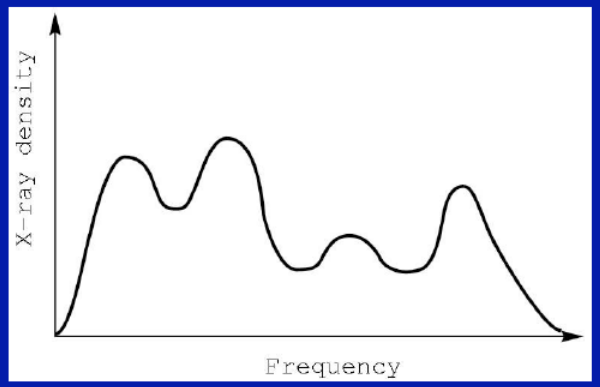
- Data volumes come in all types: tissue density (CT), wind speed, pressure, temperature, value of implicit function.
- Data volumes are used as input to a transfer function, which produces a sample volume of colors and opacities as output.
  - Typical might be a 256x256x64 CT scan
- That volume is rendered to produce a final image.



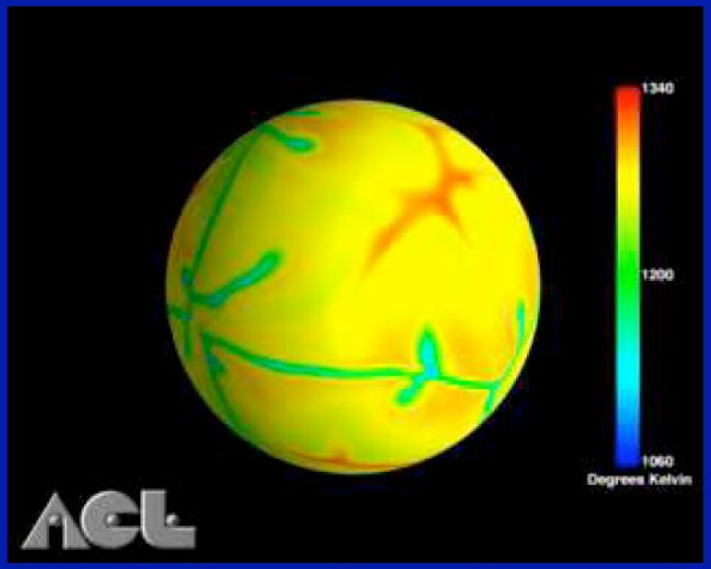
# Transfer Functions

- Transform scalar data values to RGBA values
- Apply to every voxel in volume
- Highly application dependent
- Start from data histogram



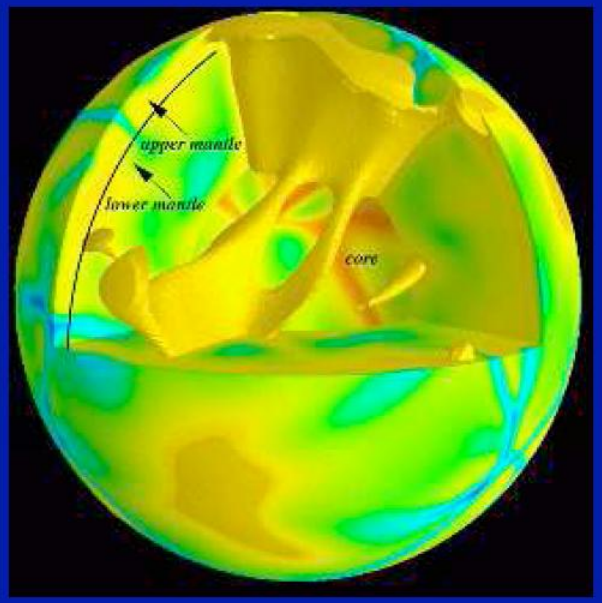



# Transfer Function Example




Scientific Computing and Imaging (SCI)
University of Utah

Mantle Convection



# Outline

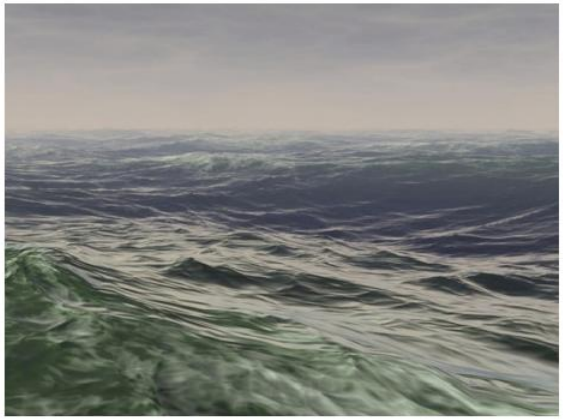
- Visualization
- **Non-photorealistic Rendering**
- Cutaway Illustration
- Contour Drawing
- Good photographs.
- Map Drawing

# Basic Idea

- Which best conveys "reality?"

Photograph.

Painting.
A Rough Sea at a Jetty, 1650.
Jacob van Ruysdael.



Computer Graphics
Duncan Brinsmead

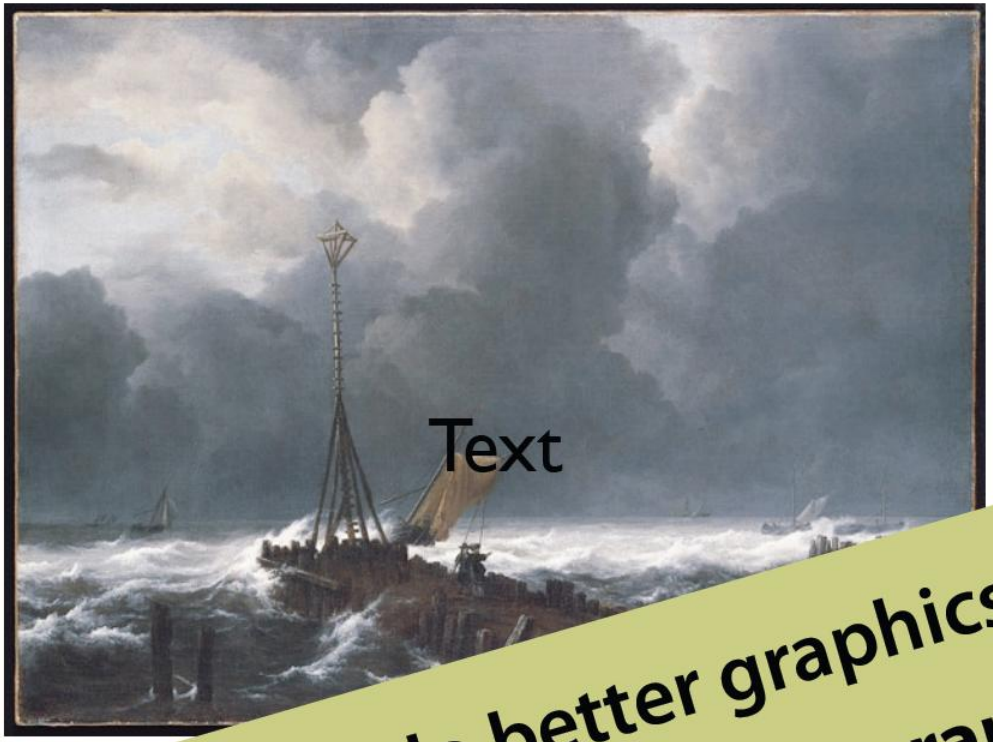
source: Jos Stam. *Photography changes what we think "reality" looks like.*

# Reality

A Rough Sea at a Jetty, 1650. - Jacob van Ruysdael.

- This instance in time never happened!
- Perhaps a better match of "subjective reality."
- Better illustration of "what was going on."

# NPR




- Perhaps we can do better graphics...
- By doing **non-photorealistic graphics!**

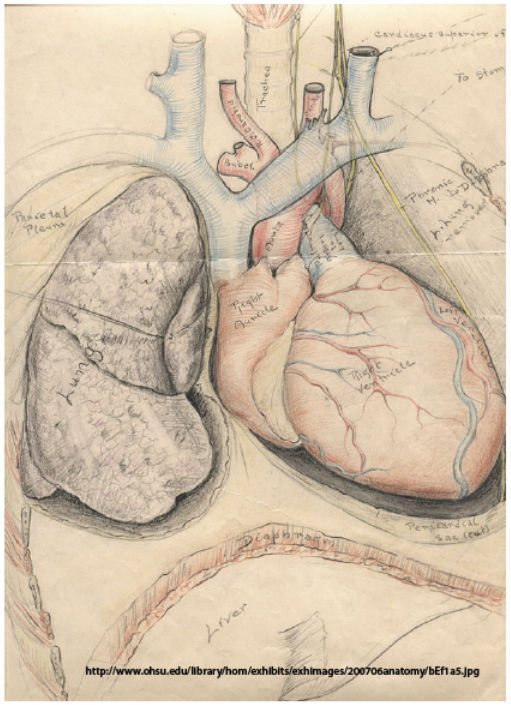
...ed!

...n of "subjective reality."

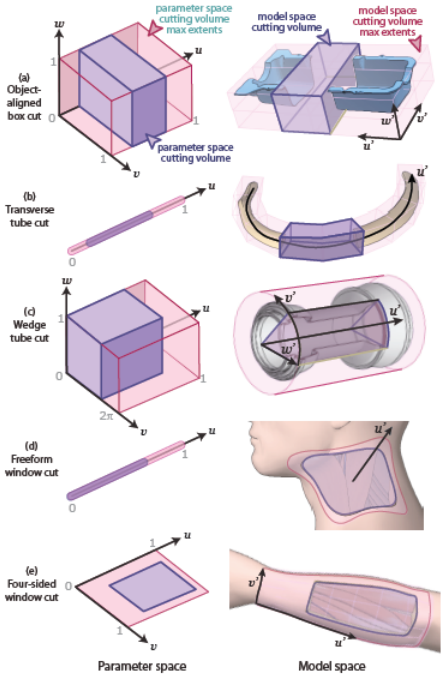
...ustration of "what was going on."

# NPR Pipeline

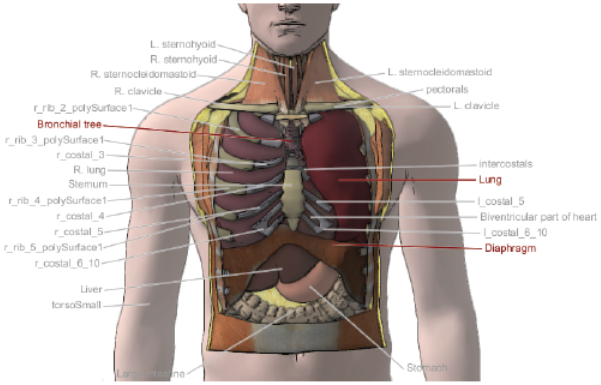
- NPR Research often follows this pipeline...




(1) Study Existing Rendering or Illustration Technique




(2) Extract General Aesthetic Rules




(b) Thorax

(3) "Algorithmicize" These Rules

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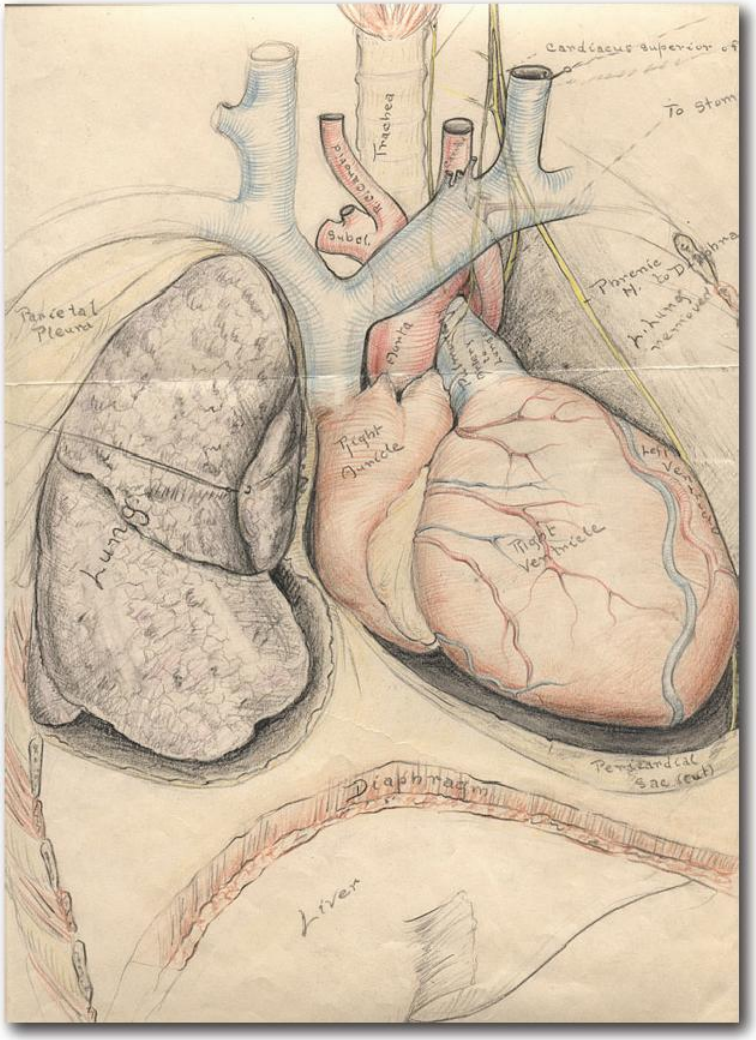
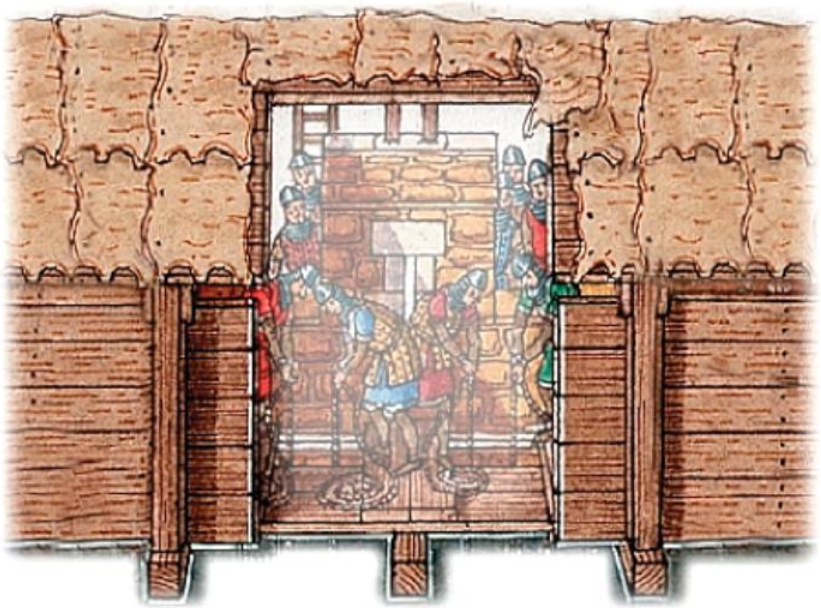
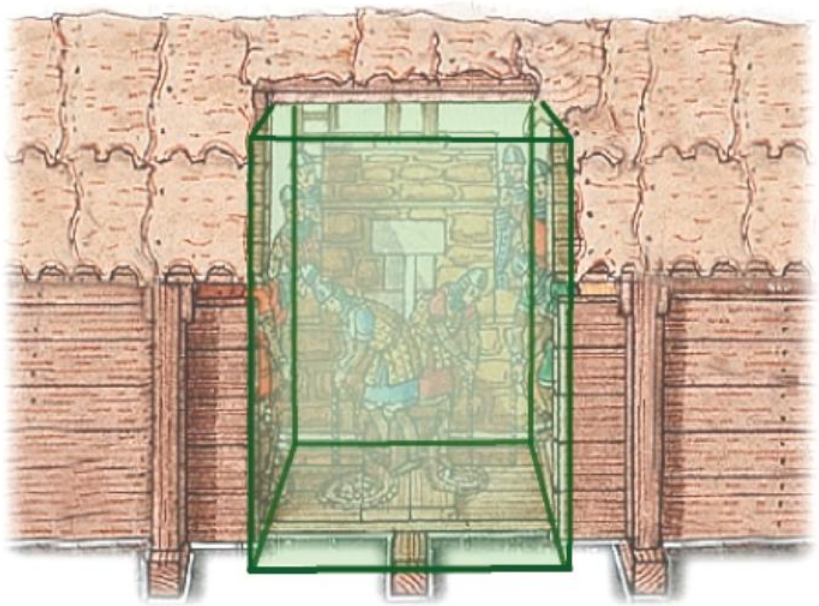
# Goal


Cardiacus superior of
To Stom
Trachea
Subcl.
Parietal Pleura
Aorta
Right Auricle
Right Ventricle
Pericardial Sac (cut)
Diaphragm
Liver

# Box Cut



# Box Cut



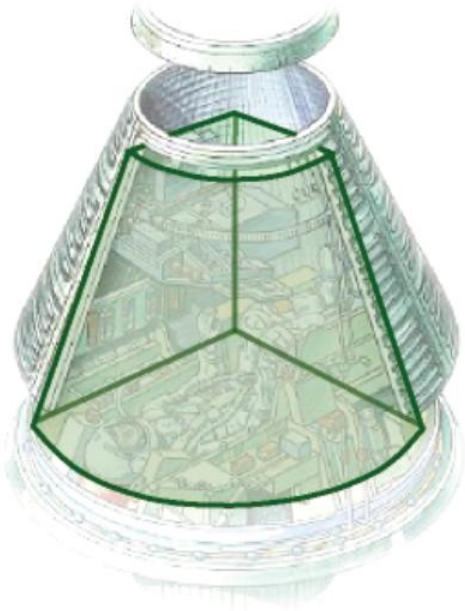
Object-aligned box cut

# Window Cut

Window cut

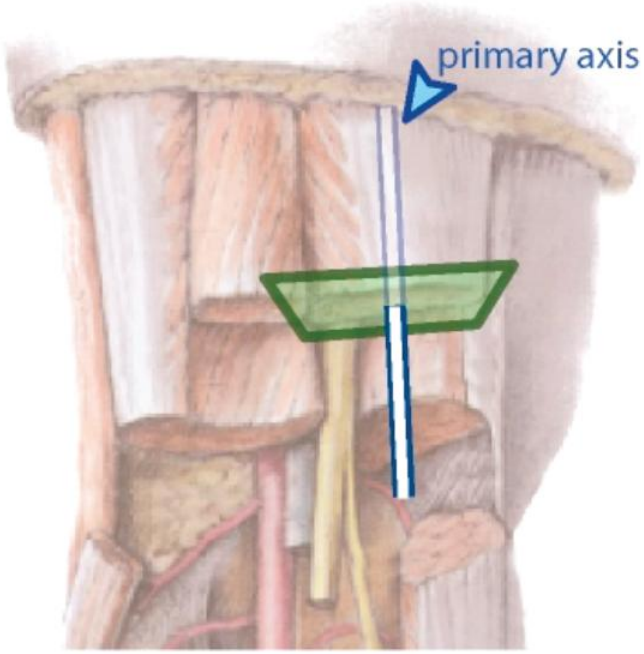
# Wedge Cut

# Wedge Cut



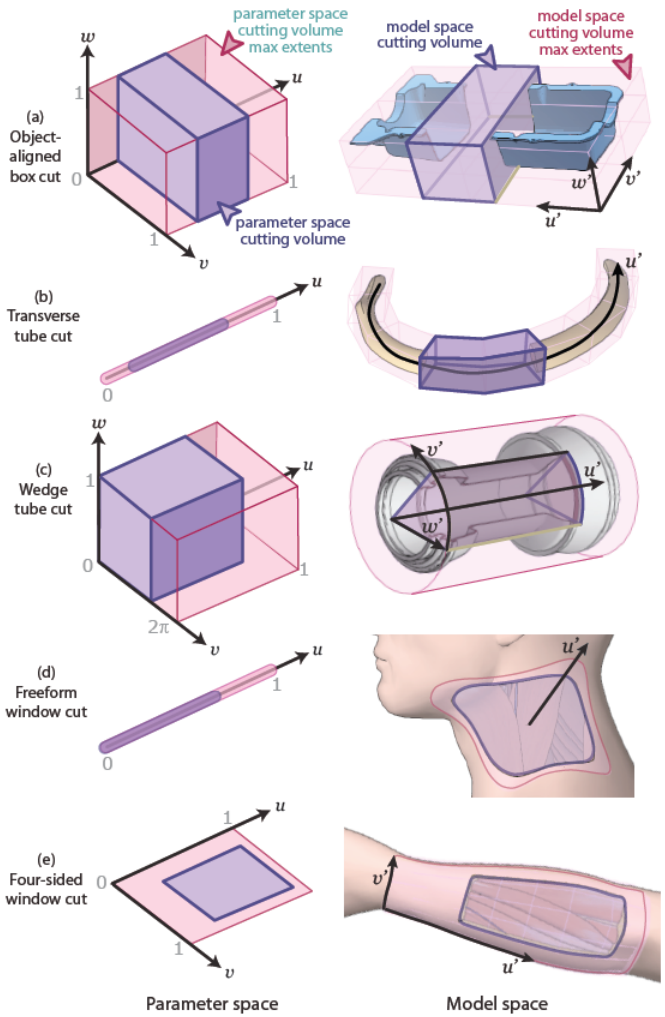
Wedge cut

# Transverse Tube Cut




Transverse tube cut

# Cut Taxonomy



# Results

## Interactive Cutaway Illustrations of Complex 3D Models

Wilmot Li [1] Lincoln Ritter[1]
Maneesh Agrawala[2] Brian Curless[1] David Salesin[1,3]

[1]University of Washington [2]University of California, Berkeley [3]Adobe Systems

(Source: Li et al. InteractiveCutawayIllustrationsofComplex3DModels)

# Outline

- Visualization
- Non-photorealistic Rendering
- Cutaway Illustration
- **Contour Drawing**
- Good photographs.
- Map Drawing

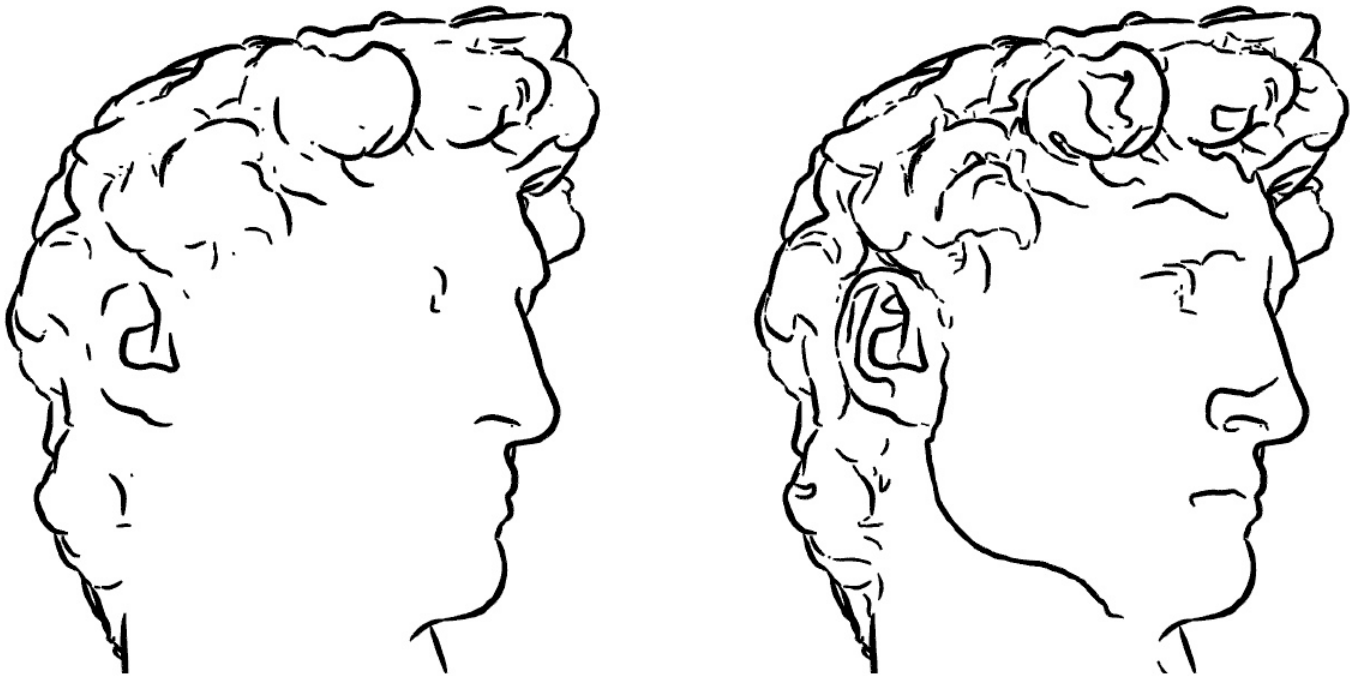
# Goal

http://www.cs.princeton.edu/gfx/pubs/Cole_2008_WDP/index.php

# Contours

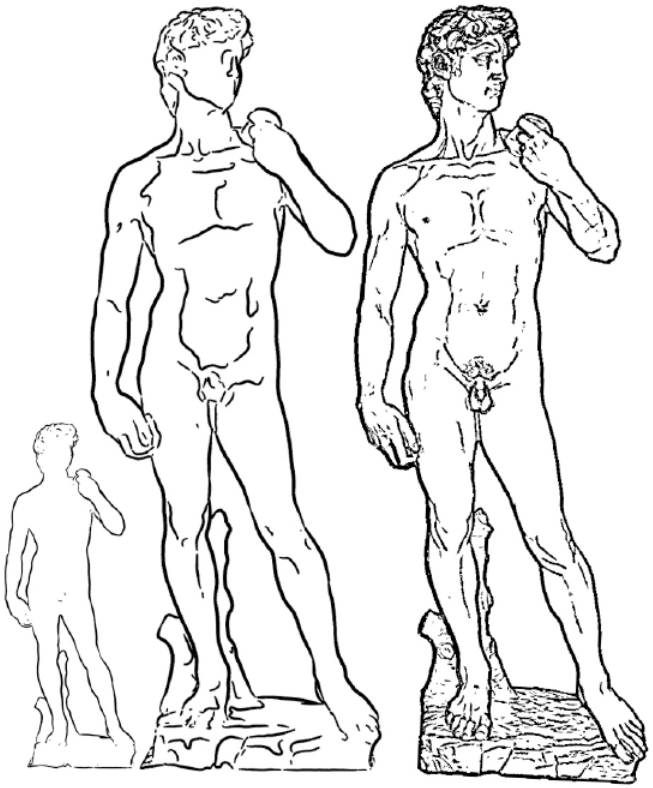
$$\mathbf{n}(\mathbf{p}) \cdot \mathbf{v}(\mathbf{p}) = 0$$

# Suggestive Contours



$$\min \ \mathbf{n}(\mathbf{p}) \cdot \mathbf{v}(\mathbf{p})$$

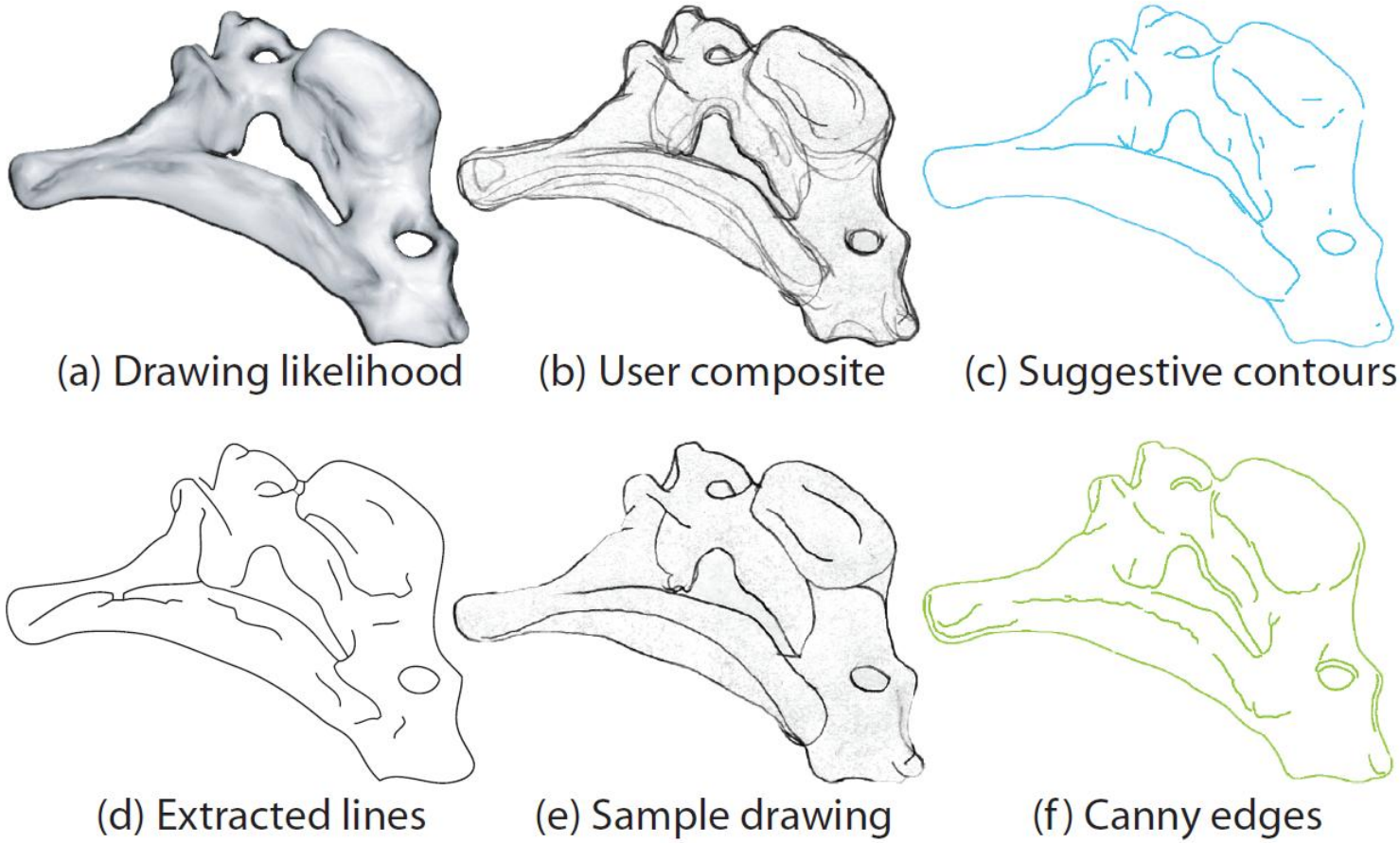
# Examples



**Suggestive Contours for Conveying Shape**

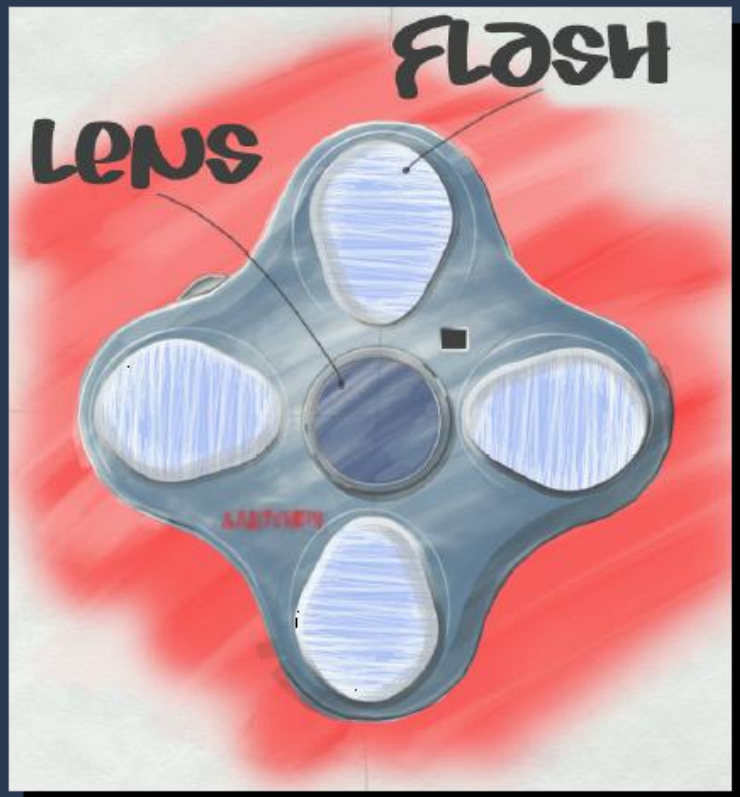
Doug DeCarlo[1] Adam Finkelstein[2] Szymon Rusinkiewicz[2] Anthony Santella[1]

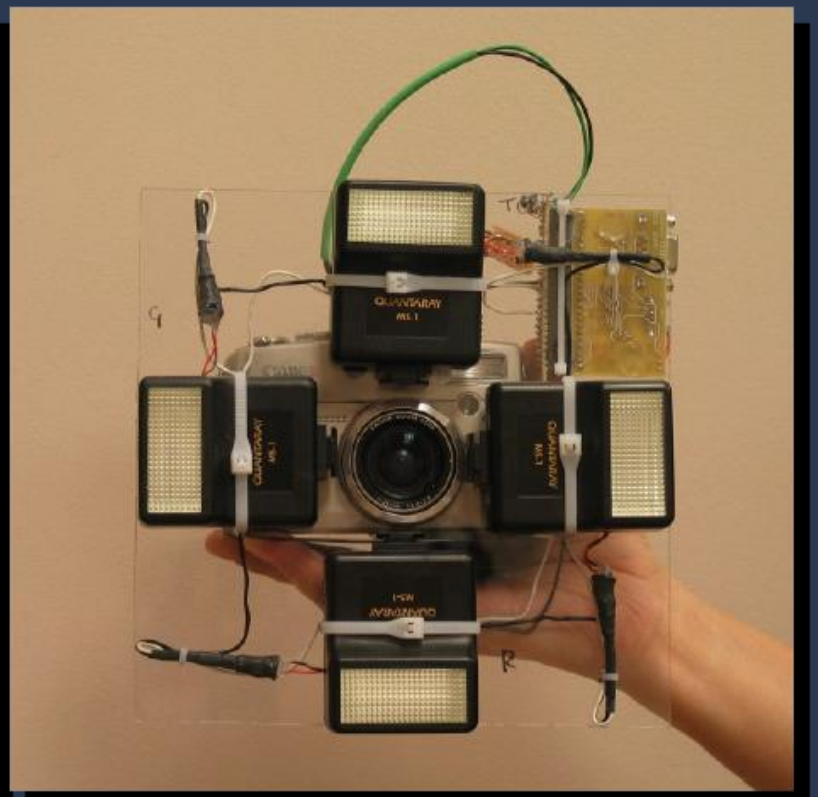
# More Examples

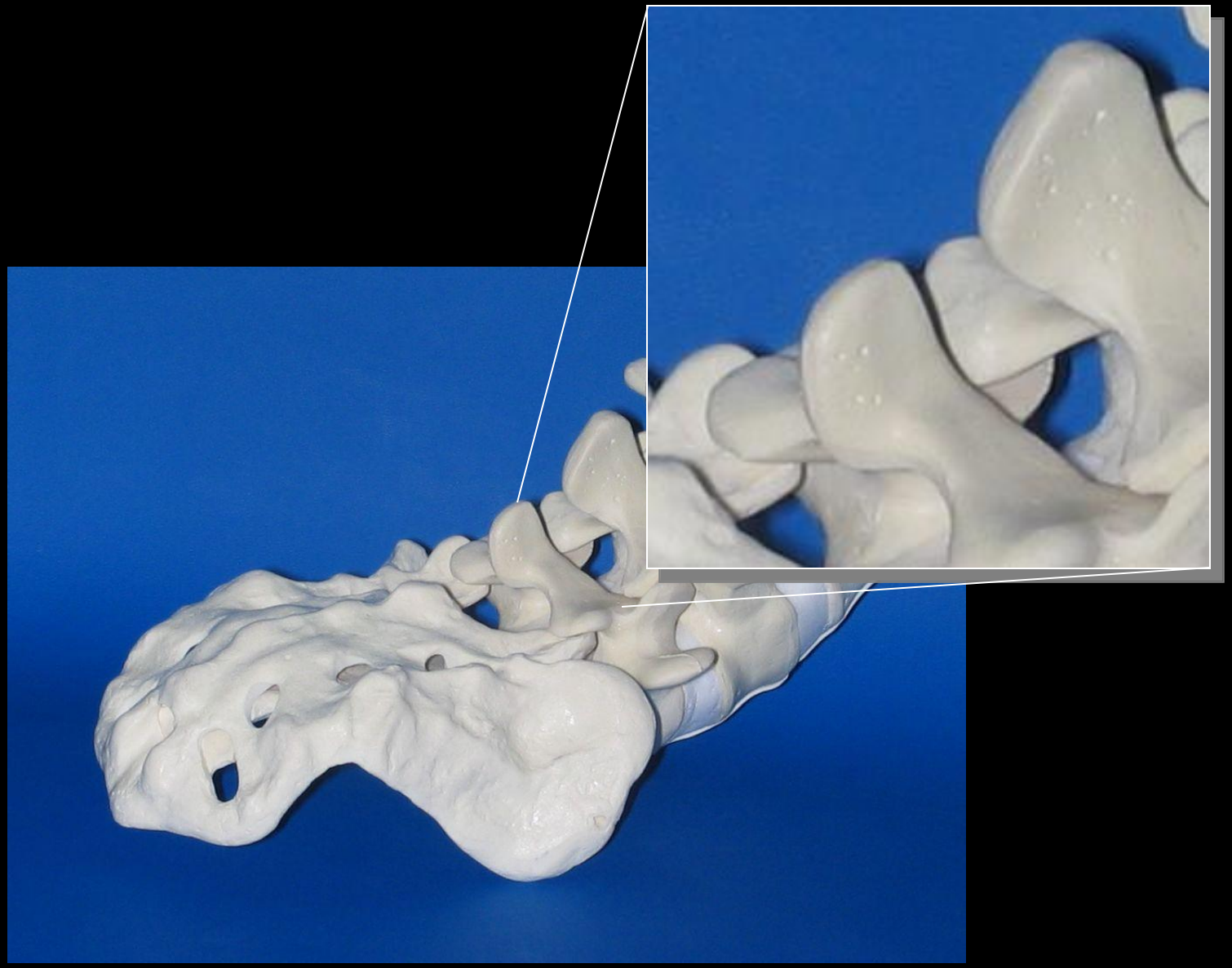



Where Do People Draw Lines?
Forrester Cole, Aleksey Golovinskiy, Alex Limpaecher, Heather Stoddart Barros, Adam Finkelstein, Thomas Funkhouser, and Szymon Rusinkiewicz

# Depth Edge Camera



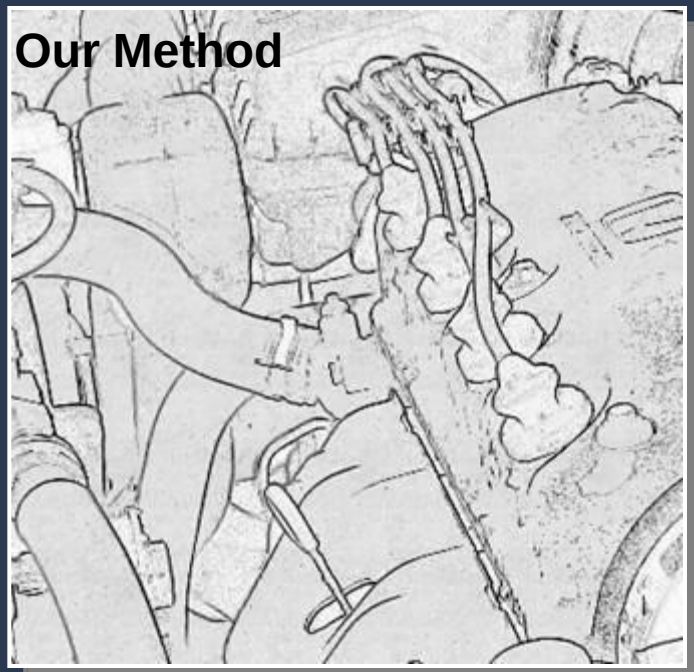


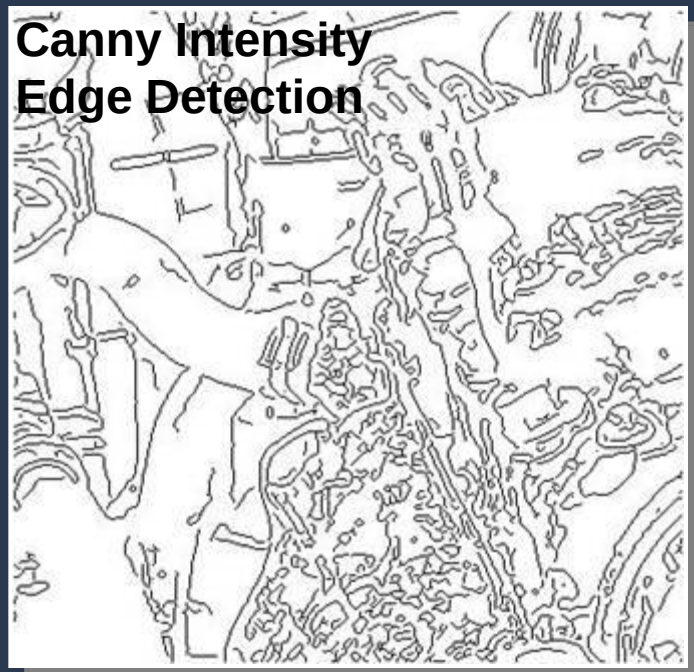
# Depth Discontinuities

Internal and external
Shape boundaries, Occluding contour, Silhouettes

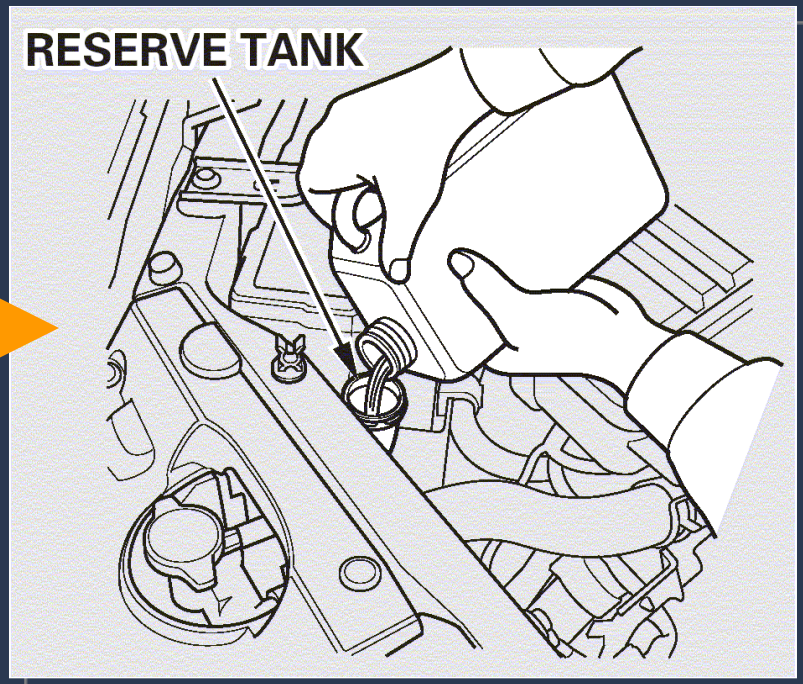

Photo


Result


Our Method


Canny Intensity
Edge Detection


Left Flash
Right Flash
Max
Top Flash
Bottom Flash
Depth Edge Confidence Map


Shadows

Clutter

Many Colors

Highlight Shape Edges

Mark moving parts

Basic colors

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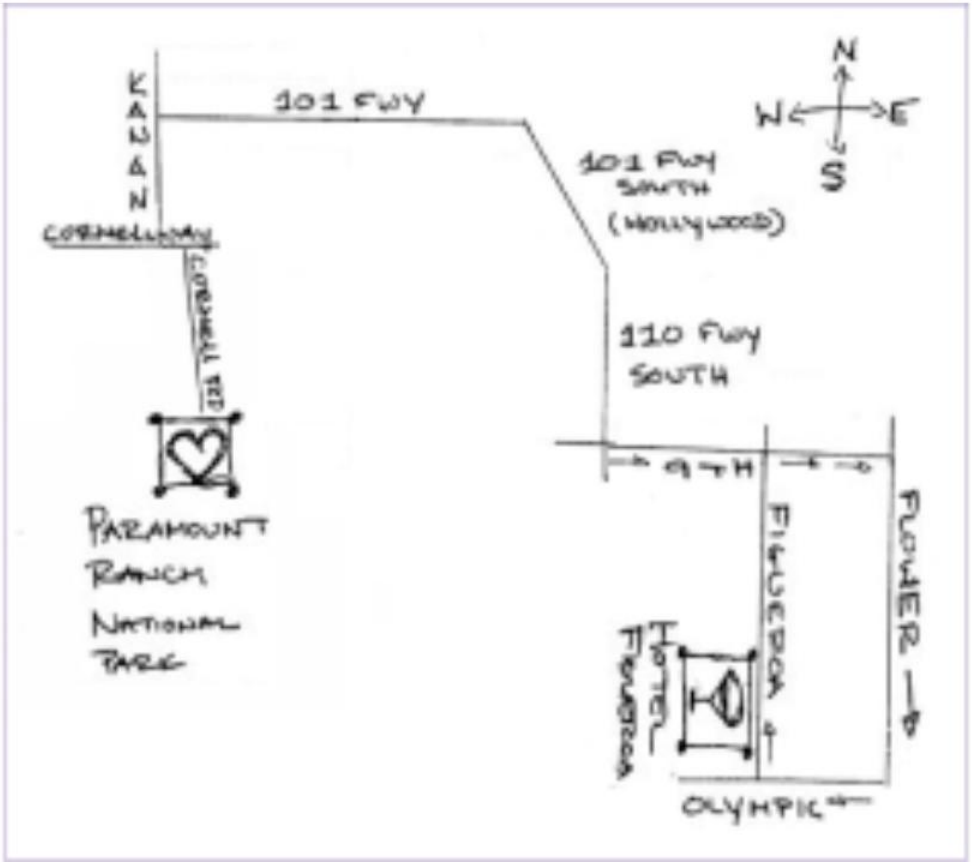
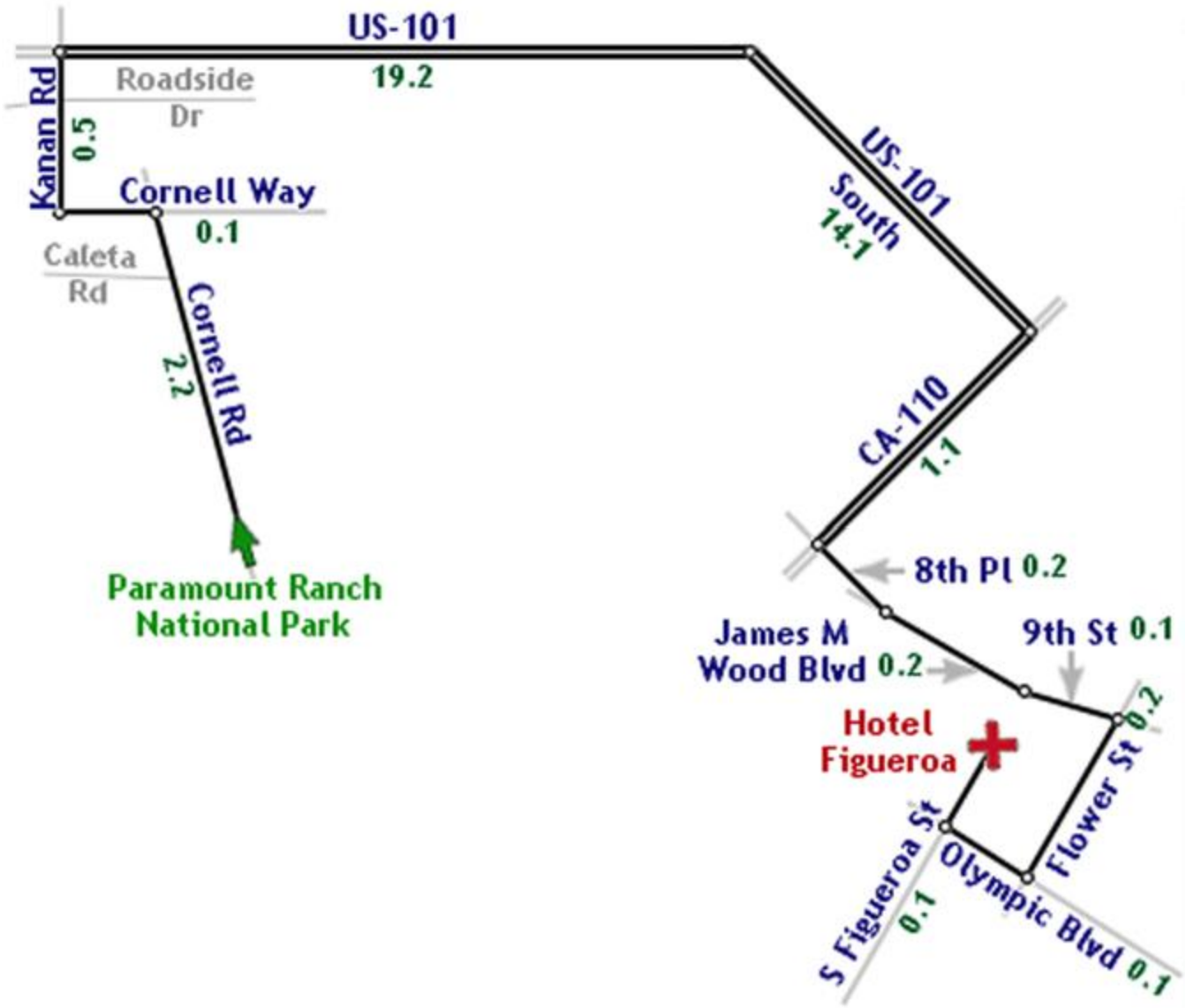
# Goal


N
W
E
S
101 FWY
SOUTH
(HOLLYWOOD)
110 FWY
SOUTH
9TH
FIGUEROA
FLOWER
OLYMPIC
HOTEL
FIGUEROA
KANAN
CORNELL WAY
CORNELL RD
PARAMOUNT
RANCH
NATIONAL
PARK

# Reality


US-101
19.2
Roadside Dr
Kanan Rd
0.5
Cornell Way
0.1
Cabeta Rd
Cornell Rd
2.2
Paramount Ranch National Park
US-101 South
14.1
CA-110
1.1
8th Pl 0.2
9th St 0.1
James M Wood Blvd 0.2
Hotel Figueroa
Flower St 0.2
S Figueroa St 0.1
Olympic Blvd 0.1
NORTH
MAPBLAST!
San Fernando
210
170
Burbank
134
Glendale
Cornell Rd
405
Beverly Hills
5
939 S Figueroa St
Culver City
10
Santa Monica
Inglewood
Pacific Ocean
El Segundo
110
105
5 mi
©2000 Mapsty Corp, ©DT, NavTech

# MapBlast / LineDrive




[Rendering effective route maps:..., Agrawala and Stolte]

# MapBlast / LineDrive

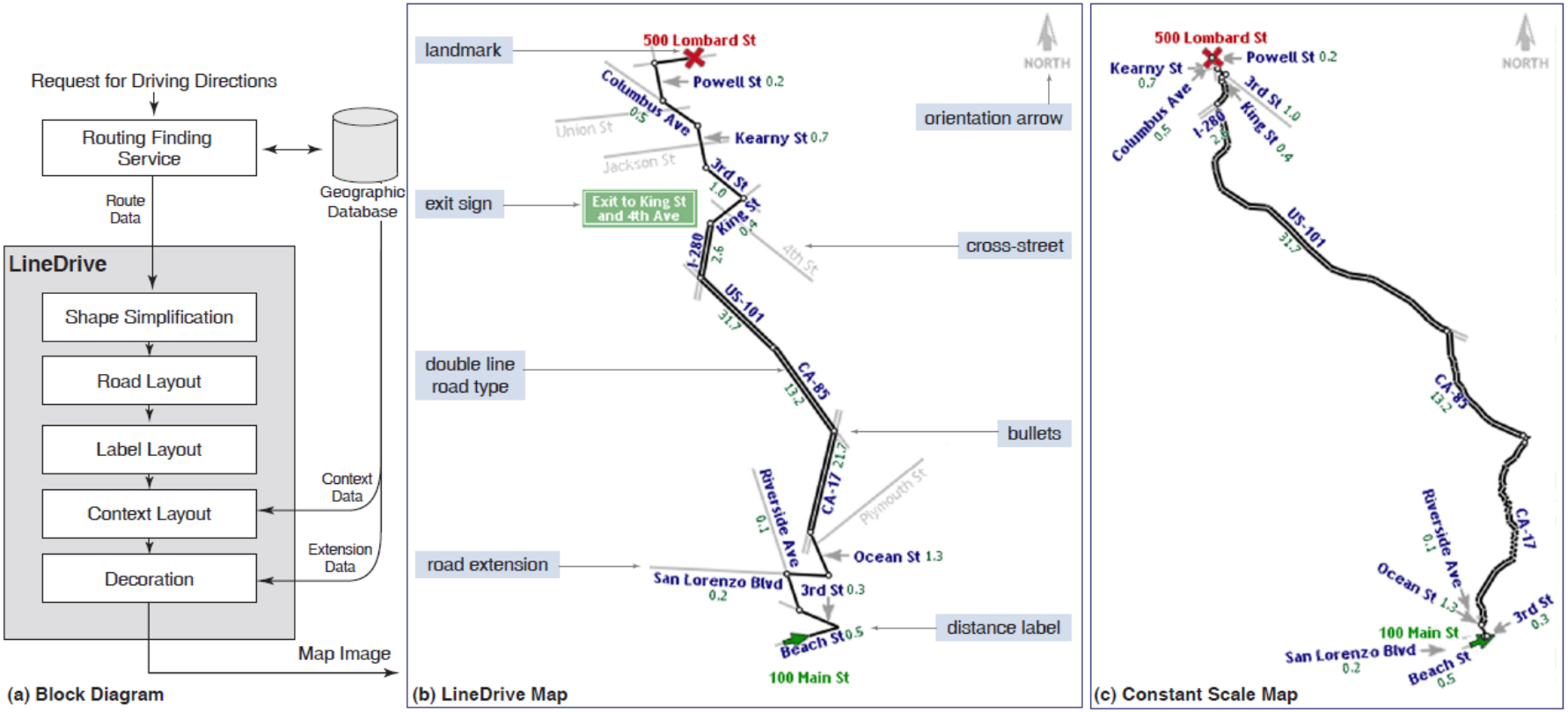



Figure 2: The LineDrive system. (a) Given a route as a sequence of roads, LineDrive designs a route map by processing the route through five consecutive stages. (b) The resulting LineDrive map. (c) The same map rendered without applying the generalization techniques performed by LineDrive. The constant scale factor and retention of detailed road shape make it difficult to identify many of the roads.

# MapBlast / LineDrive