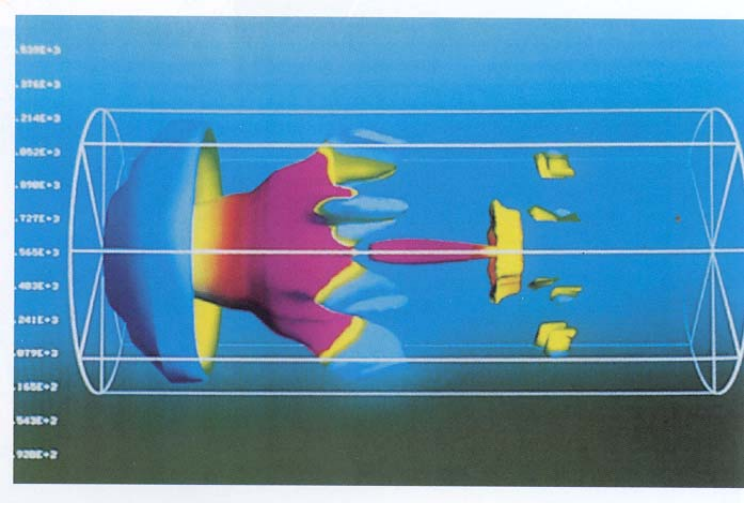
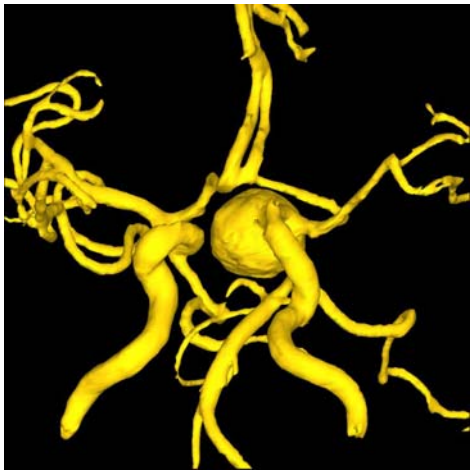
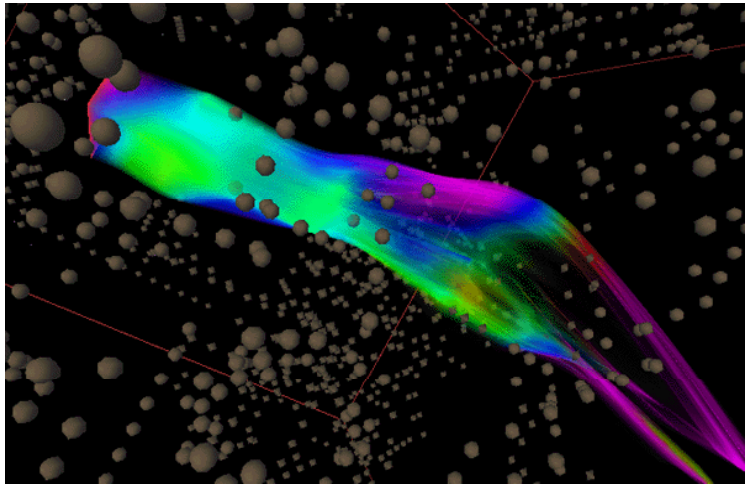
Introduction

- Visualization : The use of **computer-supported**, interactive, visual representations of **data** to amplify cognition
- Scientific Visualization
  : visualization of physically based data
- Information Visualization
  : visualization of abstract data

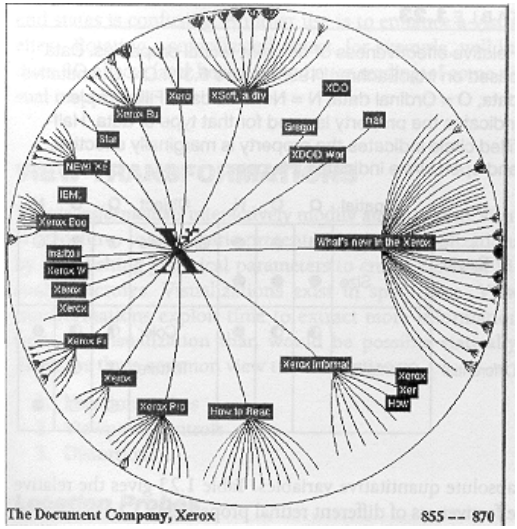
Scientific Visualization

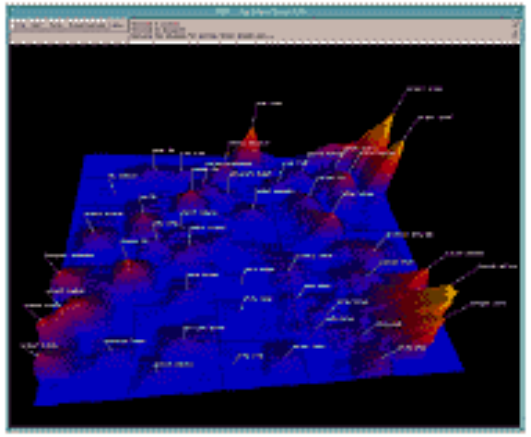


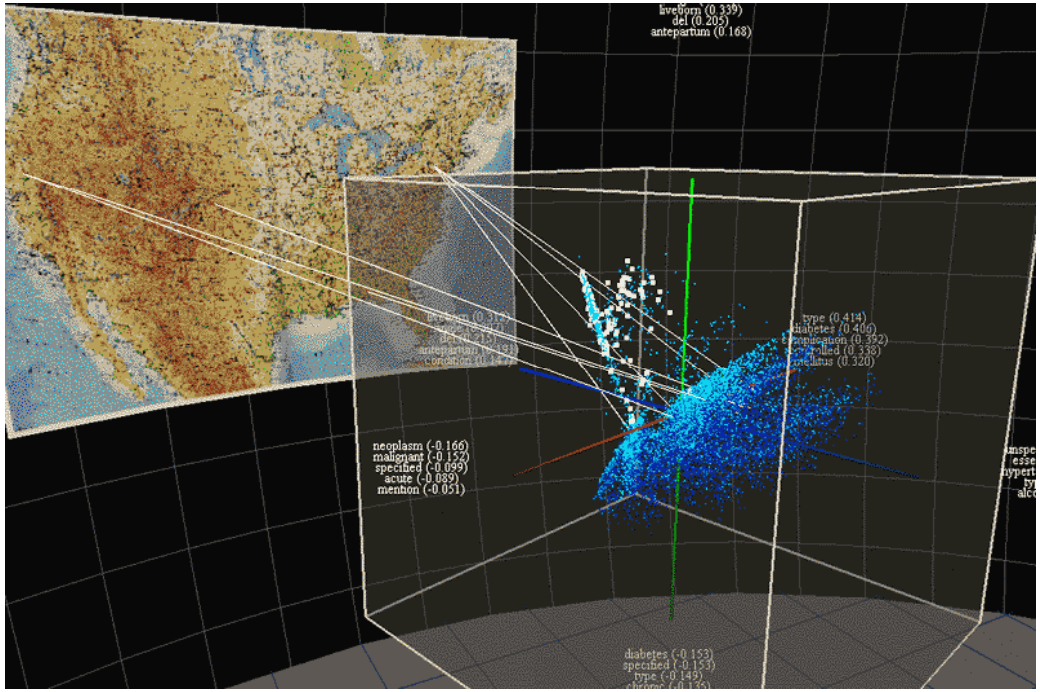




Information Visualization

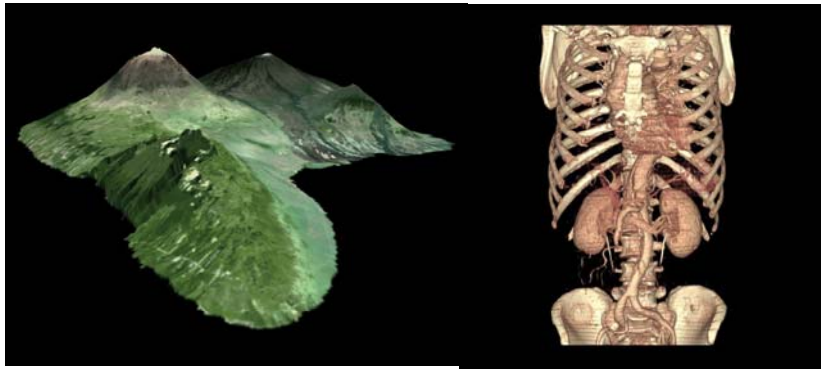






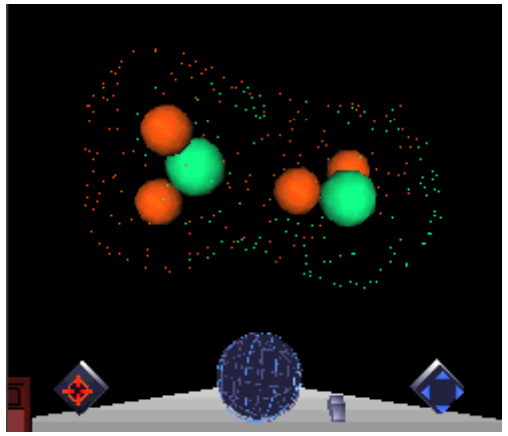
Why Visualize Data?

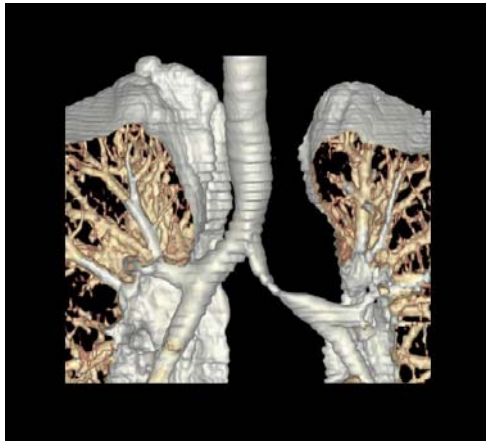
- Visualization Amplifies Cognition
  - Increased Resources
  - Reduced Search
  - Enhanced Recognition of Patterns
  - Perceptual Inference
  - Perceptual Monitoring
  - Manipulable Medium



Applications(1/4)

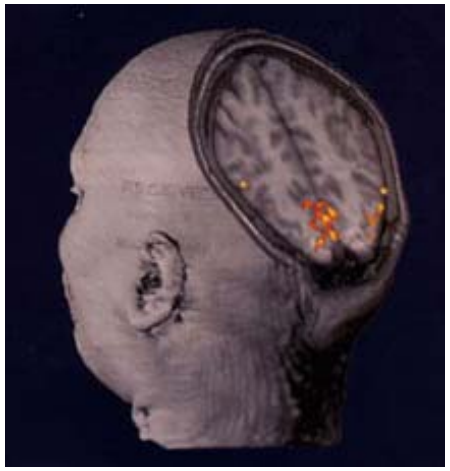
- Molecular Modeling
  - Gain insight into chemical complexity
  - Raster equipments to create realistic representation and animations
  - Vector equipments for real time display and interaction
- Medical Imaging
  - Diagnostic medicine, Surgical planning, Radiation treatment planning
  - 2D/3D visualizations of the body previously inaccessible to view





Applications(2/4)

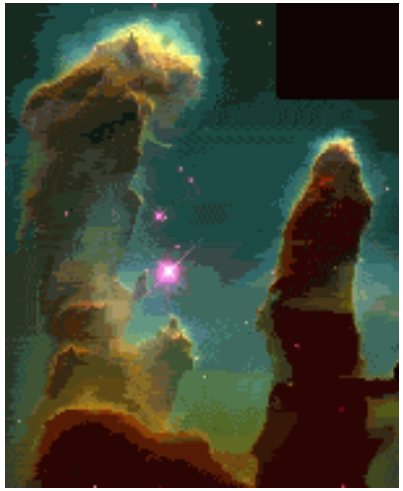
- Brain Structure and Functions
  - Determine the positions and shape of difficult-to-identify organs
  - Obtain information about the anatomical position of the suspected lesions

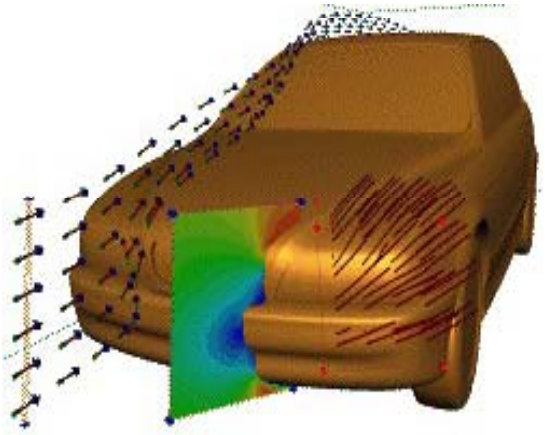


- Mathematics
  - Visualization helps mathematicians understand complex equations

Applications(3/4)

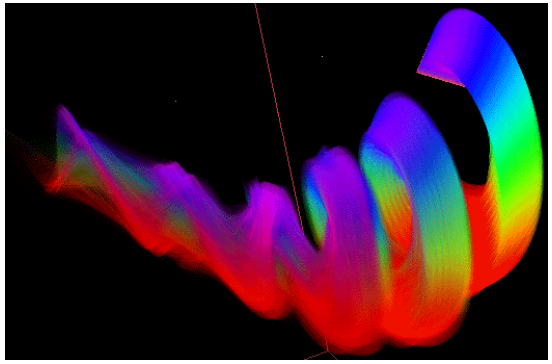
- Astrophysics
  - See the unseen and create visual paradigms for phenomena that have no known visual representation
  - Visualization numerical relativity equations
- Computational Fluid Dynamics
  - Describe the flow of a fluid or gas with magnetic fields
- Finite Element Analysis
  - Calculate stress/strain distribution



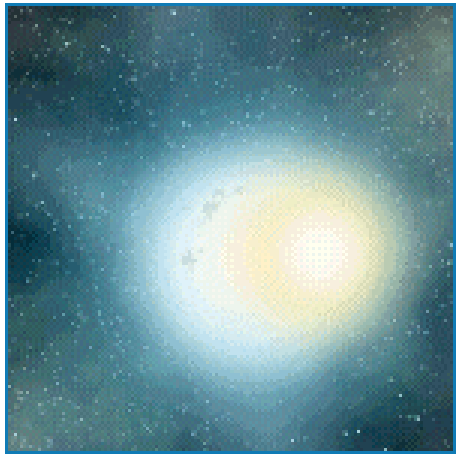


Applications(4/4)

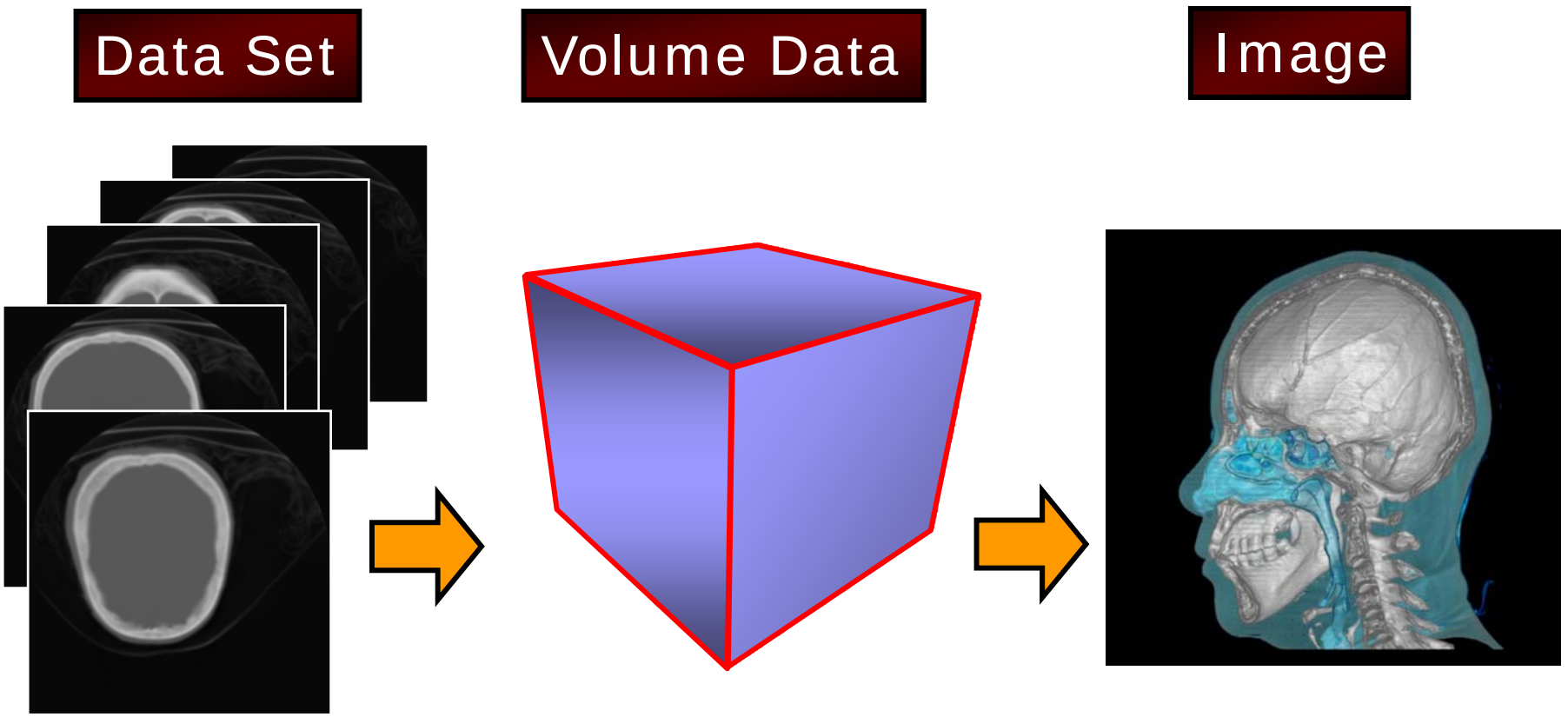
- Geosciences (Meteorology)
  - Helps understand the atmospheric conditions that breed large and violent tornadoes
  - Obtain information that cannot be safely observed



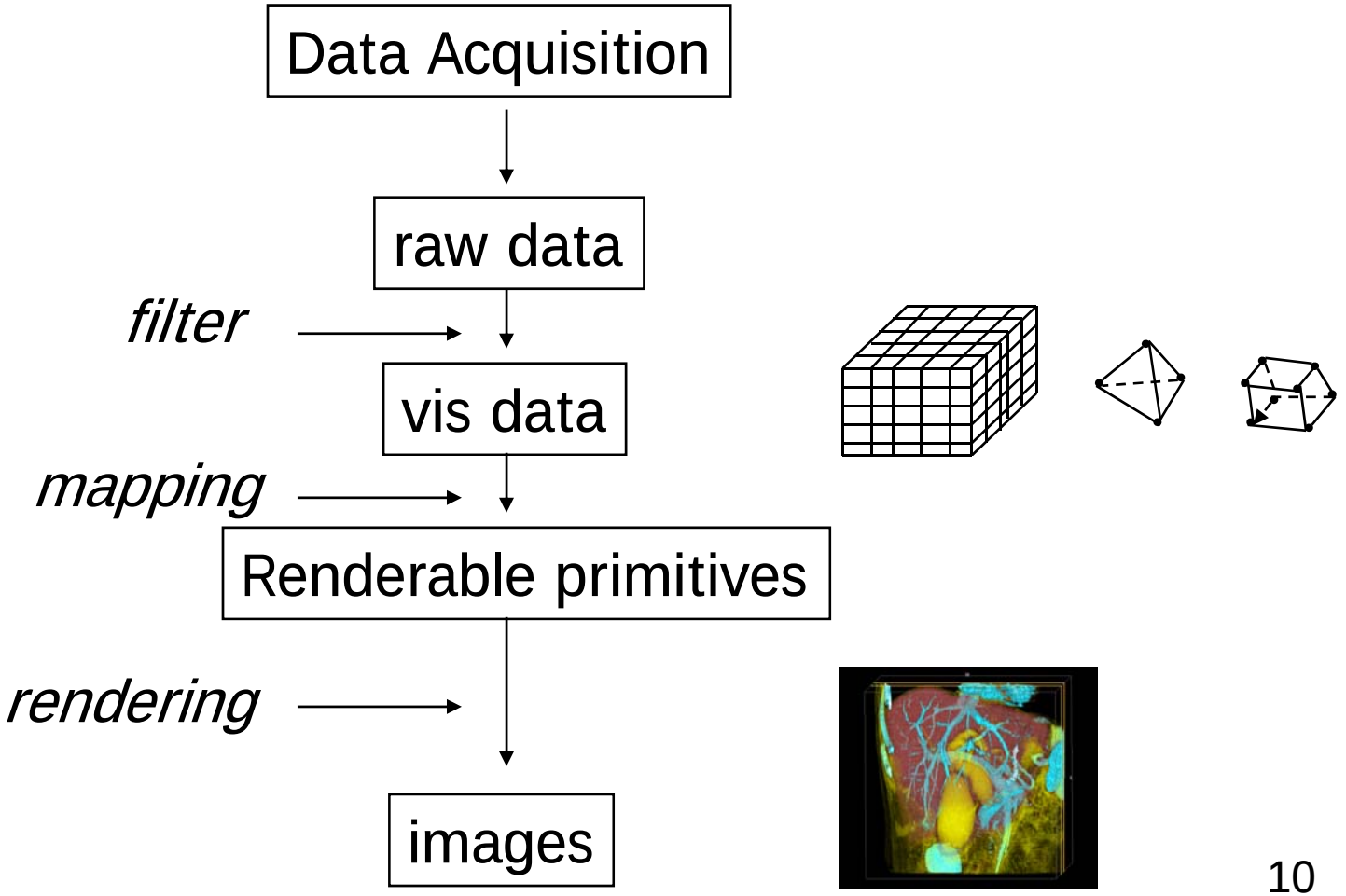
- Space Exploration
  - Integrate huge amount of observed phenomena and theory from other fields involved in planetary study



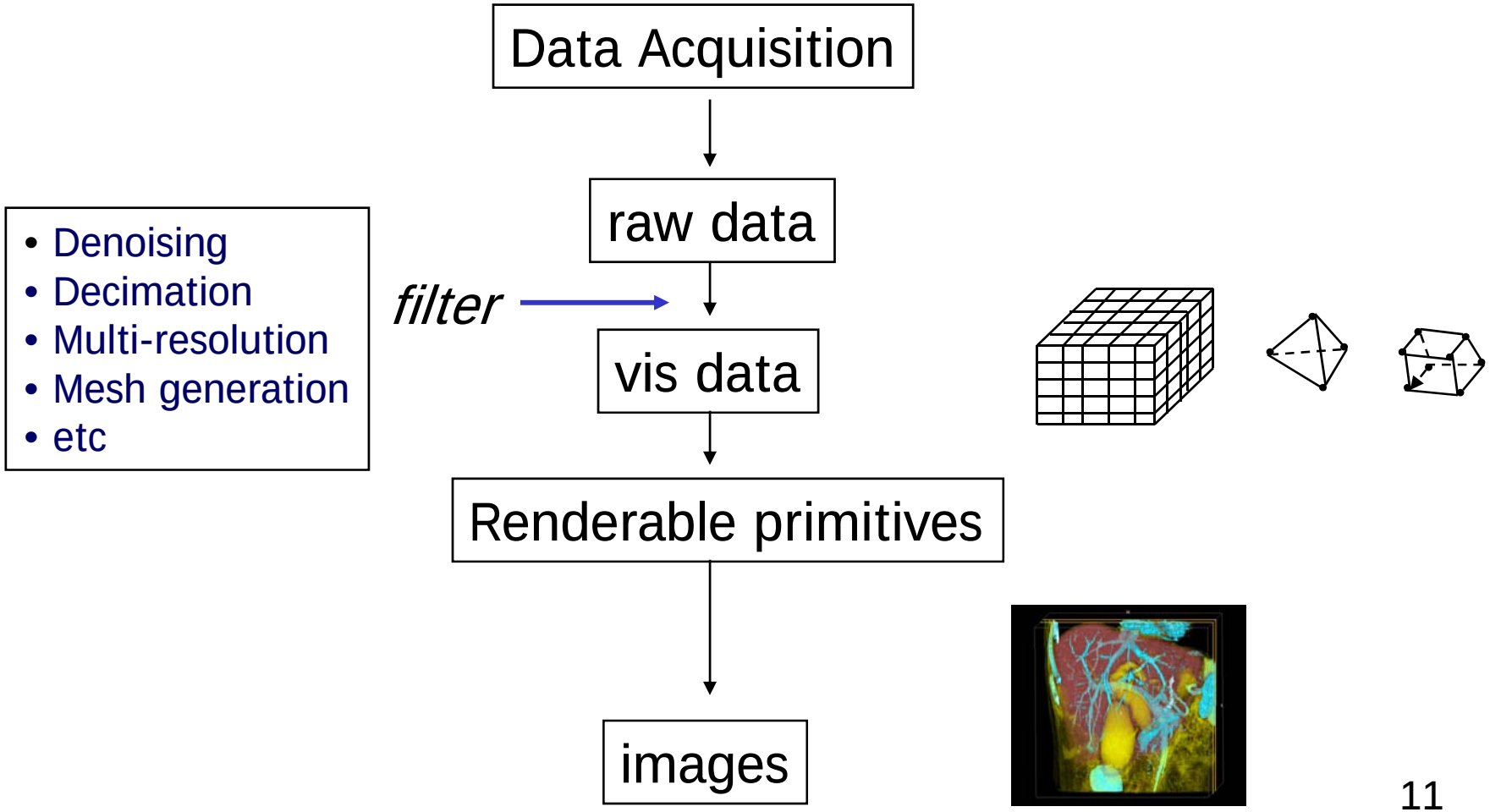
Visualization Process



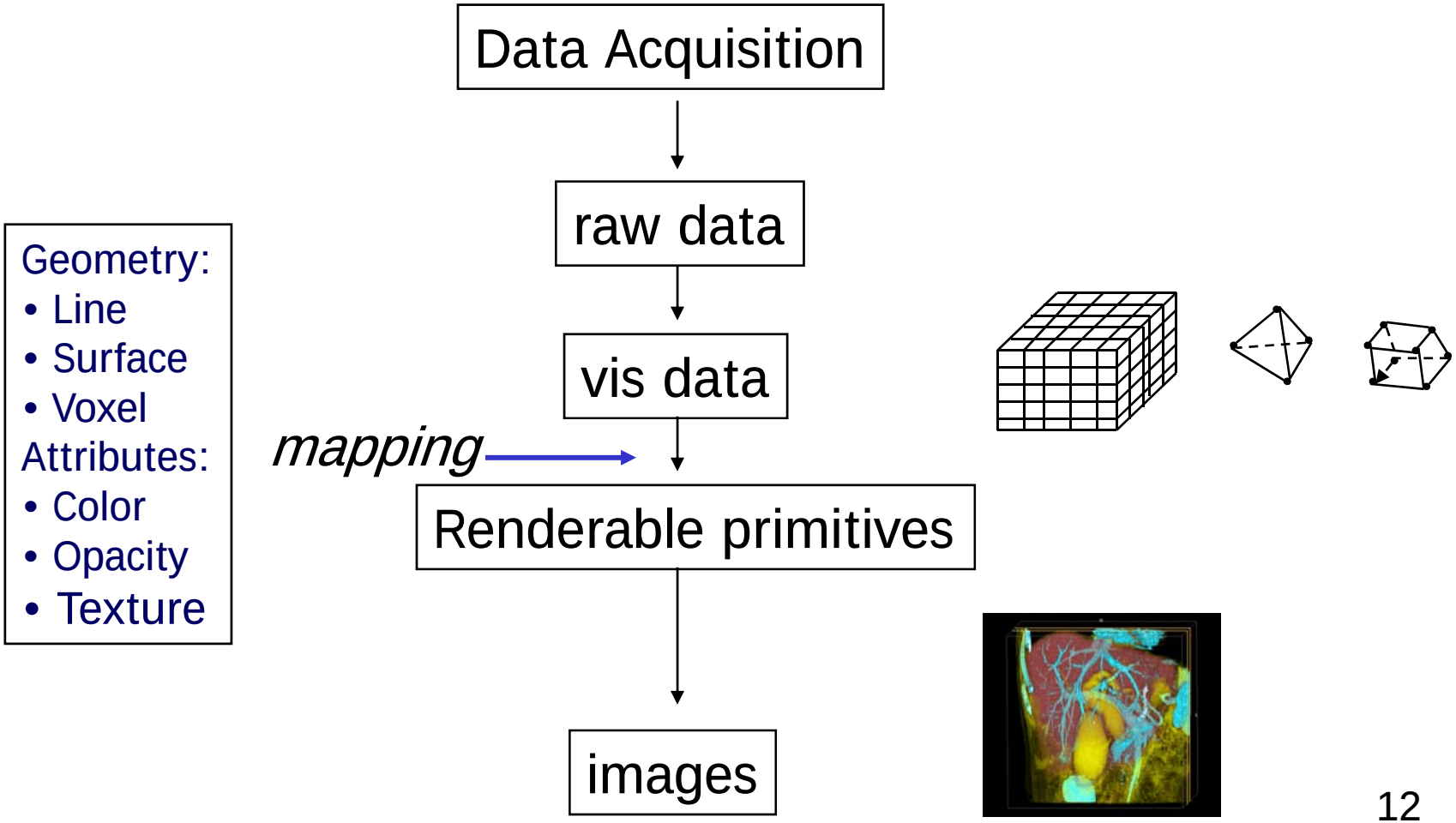
Visualization Pipeline



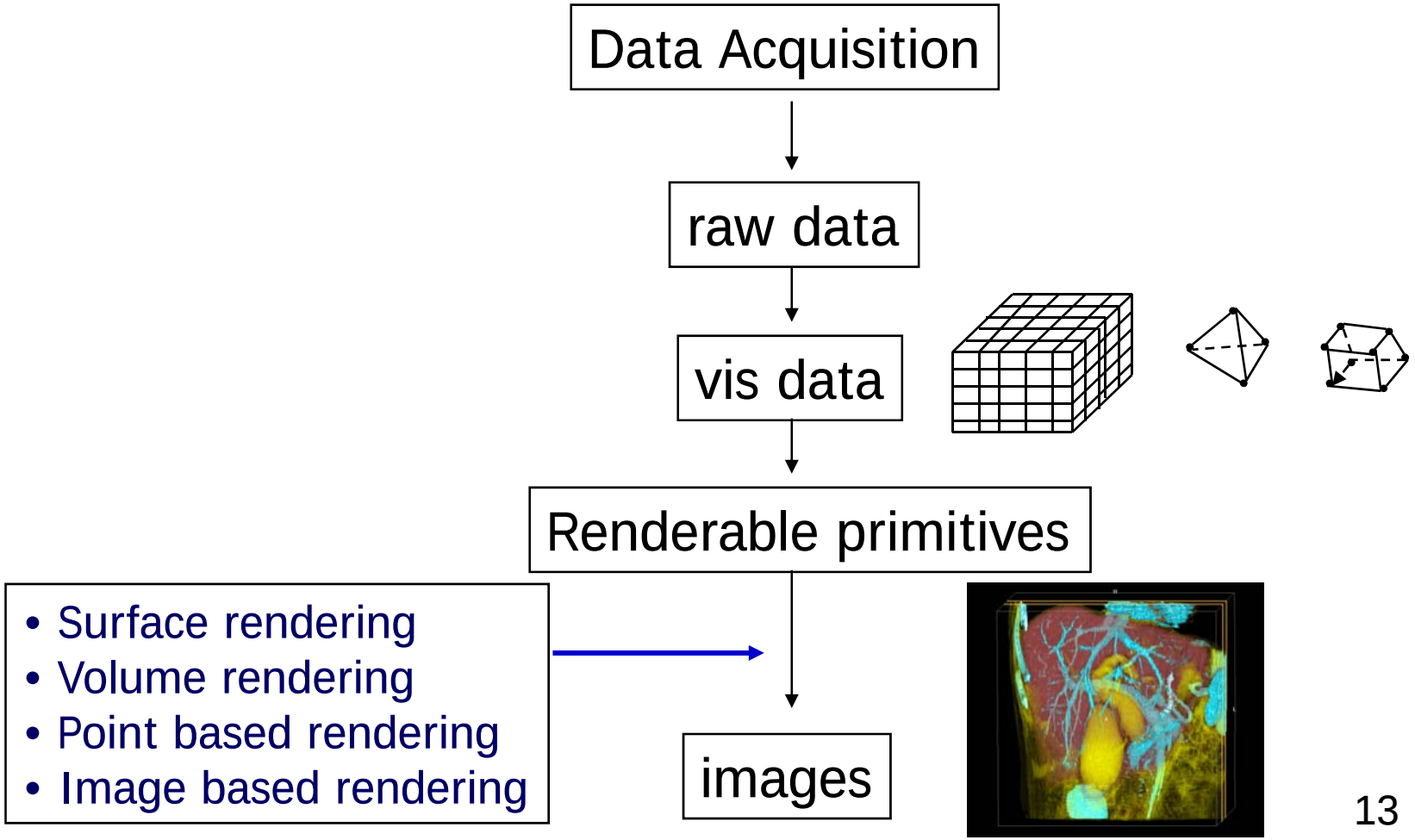
Visualization Pipeline



Visualization Pipeline



Visualization Pipeline

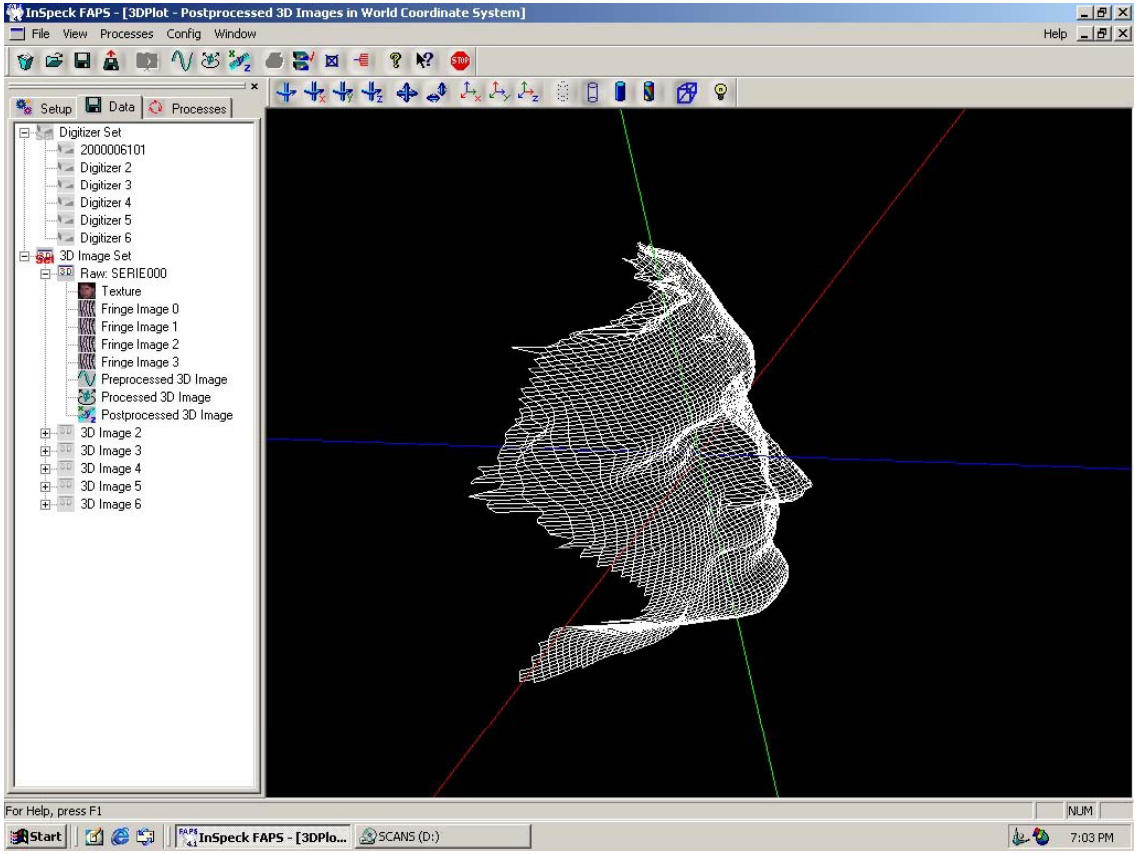


Data Acquisition

- Scanned/Sampled data
- Computed/Simulated data
- Modeled/Synthetic data

Acquisition of Data

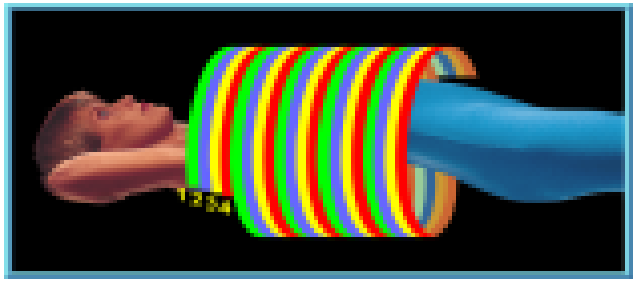
- Scanned Data

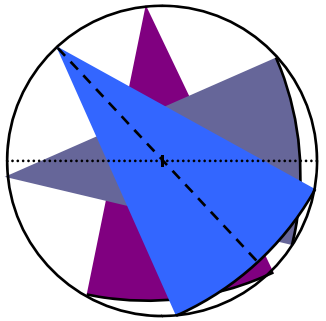


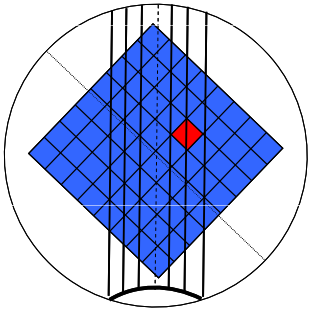
Acquisition of Data (CT)

- Computed Tomography (CT)
  - measures spacially varying X-ray attenuation coefficient
  - spiral CT: each slice 1-10mm thick
  - MDCT : 4, 16 slices , thickness < 1mm
  - high resolution:512 x 512 pixels, 0.5-2mm in size
  - low noise
  - consistent signal values
  - good for high density solids

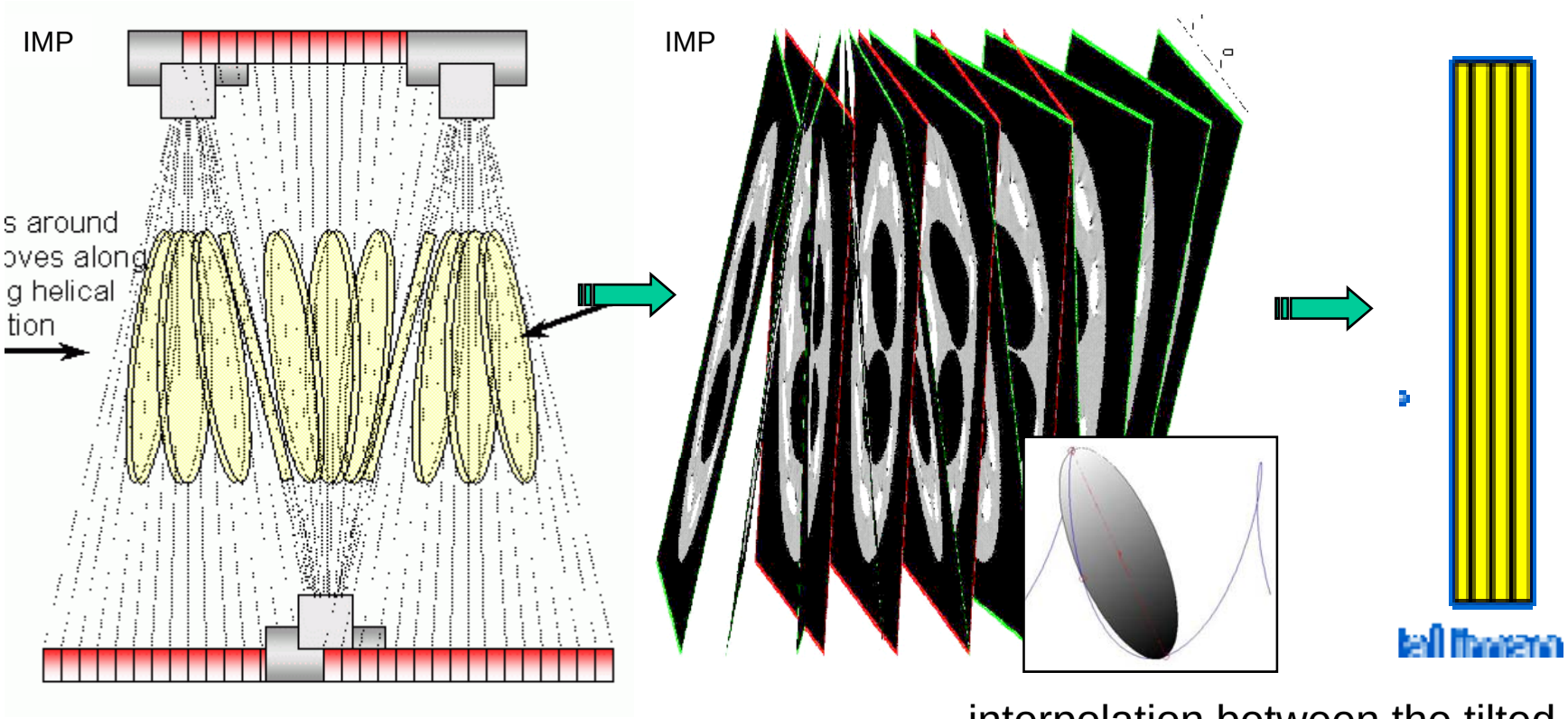
CT Scanner







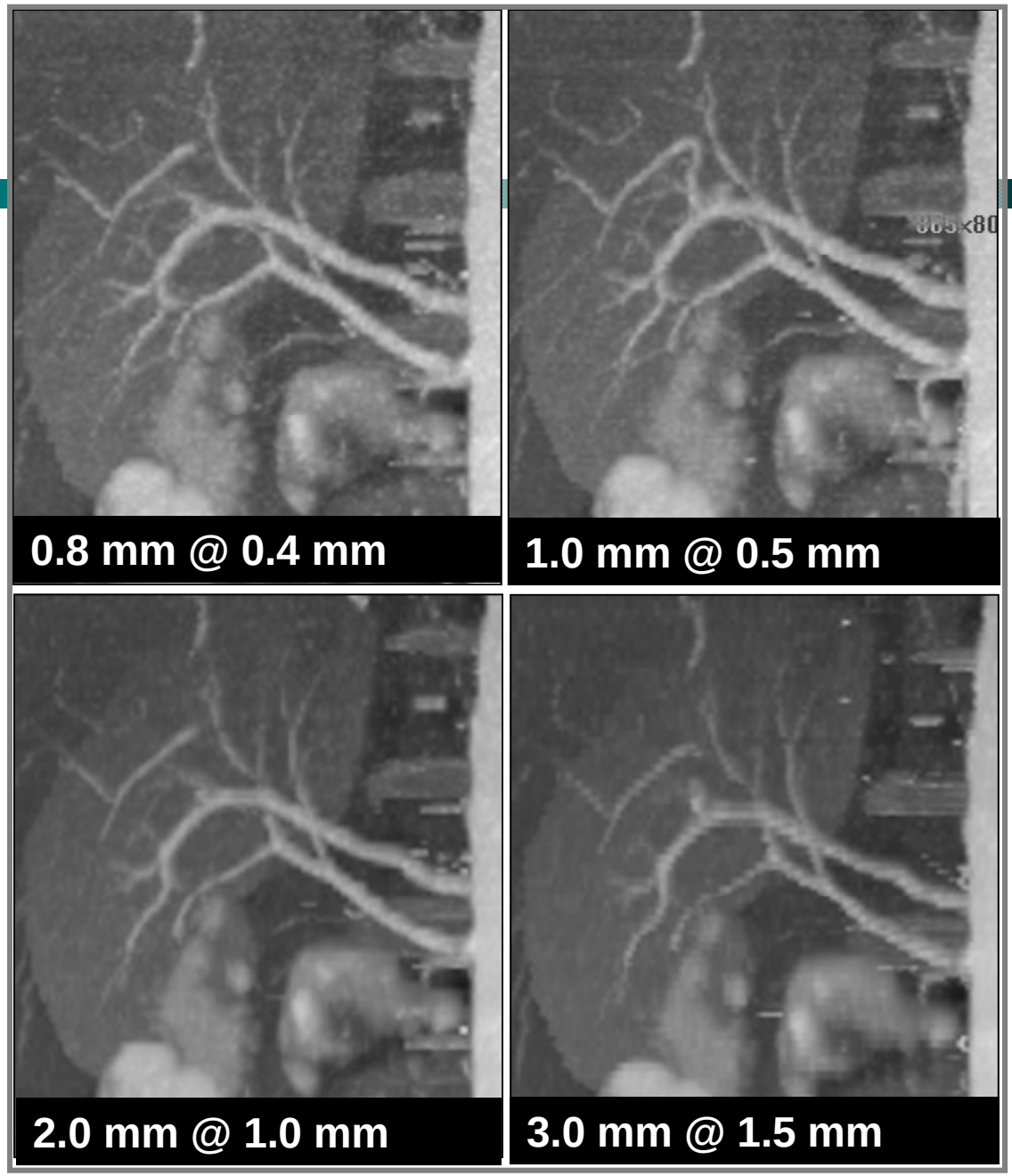
Reconstruction (CT)



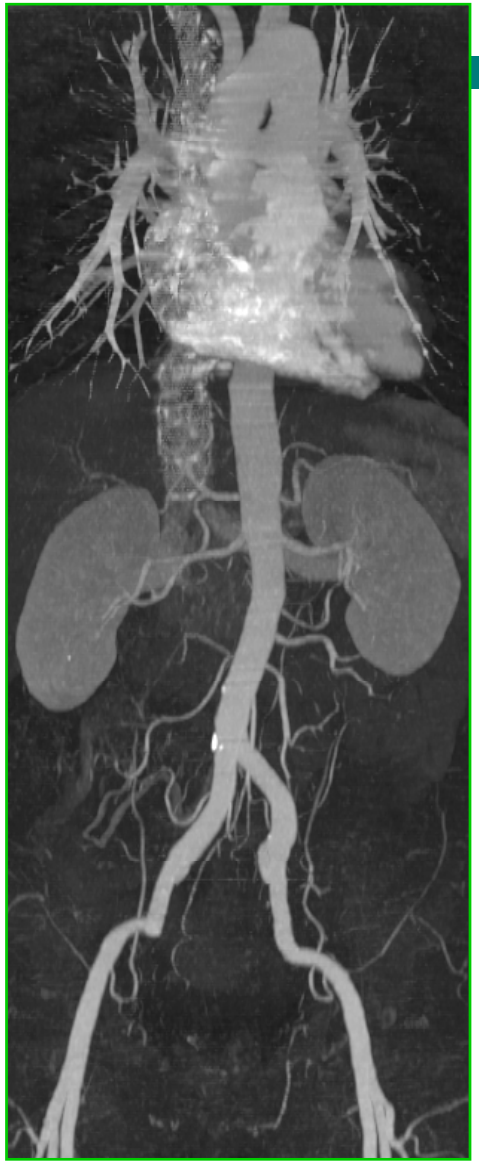
backprojection

interpolation between the tilted original image planes

CT Scans



Evolution of Spiral CT Scanner



Coverage: 80 cm

Detector row	1	4	16
Rotation/s	1	2	2.4
Pitch	2:1	2:1	2:1
Scan time (s) (2mm th.)	200	25	7
Recon. time (min) (1mm)	108	7	2

Acquisition of Data (MRI)

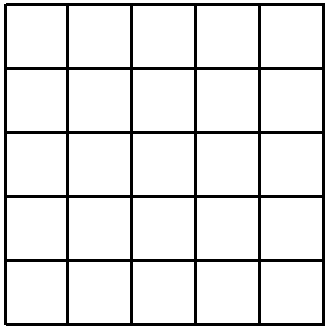
- Magnetic Resonance Imaging (MRI)
  - measures distribution of mobile hydrogen nuclei by quantifying relaxation times
  - 256x256 pixels
  - voxels are small as 1mm, but variable
  - 5-10 minutes for one sequence
  - moderate noise
  - inconsistent signal values
  - works well with soft tissue

Acquisition of Data (UltraSound)

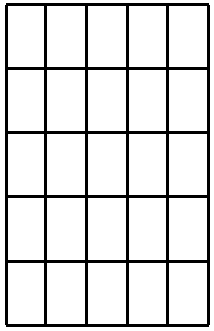
- Ultrasound
  - hand held probe
  - inexpensive, fast, and real-time
  - wedge shaped image
  - generally an analog device
  - high noise with moderate resolution

Types of Datasets

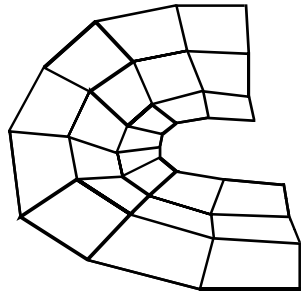
Structured Grids: topologically equivalent



uniform(cubes in 3D)

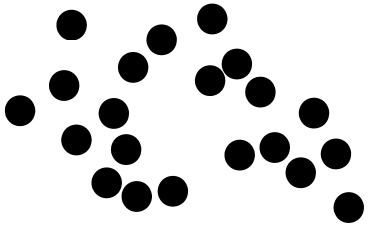


Rectilinear (bricks)

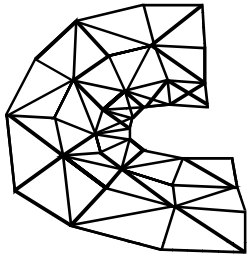


curvilinear

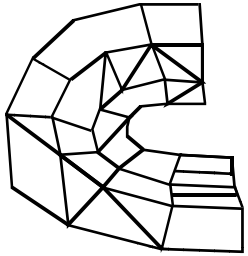
Unstructured Grids:



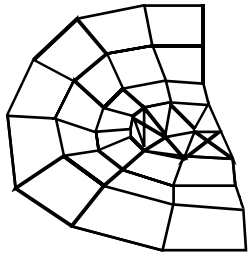
points



Regular
(tetrahedron cell)

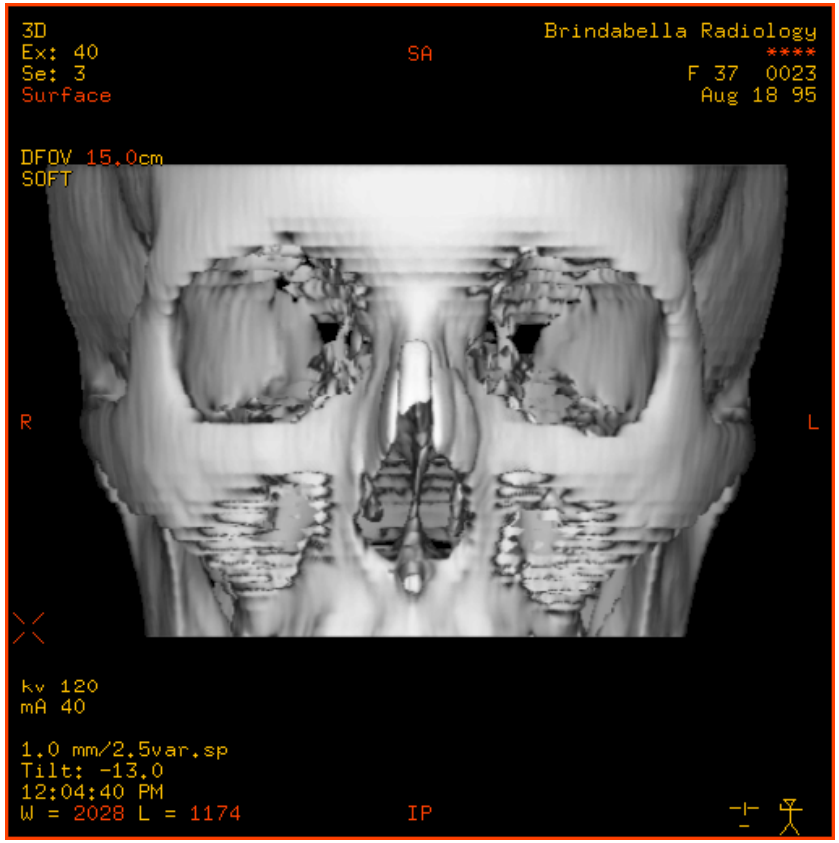


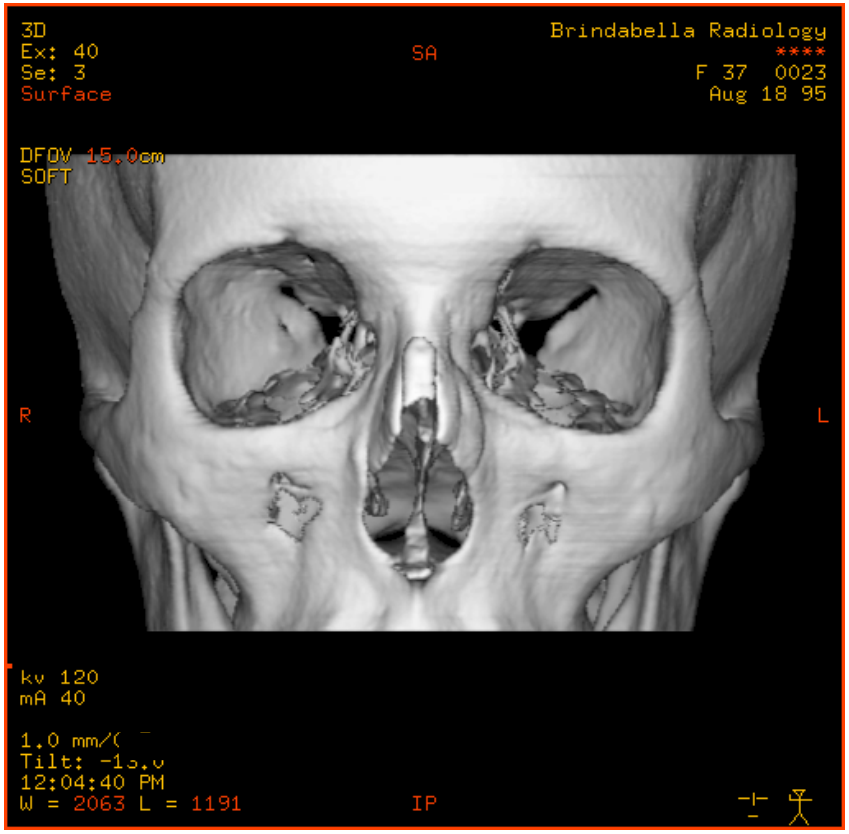
irregular



hybrid

Structured Data Examples





3 mm Slice Thickness, 3mm Recon

3 mm Slice Thickness, 1mm Recon

Unstructured Data Examples