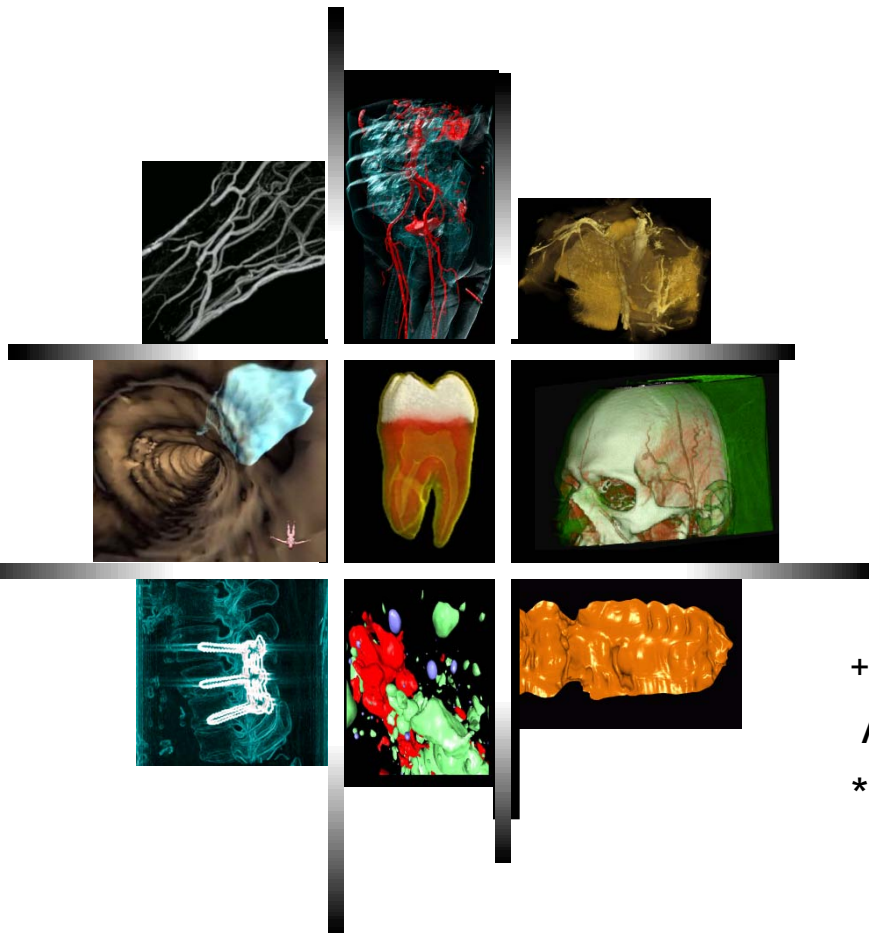


Visualisierung



Eduard Gröller⁺
Helwig Hauser^{*}

⁺Institute of Computer Graphics and Algorithms (ICGA), VUT Austria

^{*}Department of Informatics, UiB Bergen, Norway



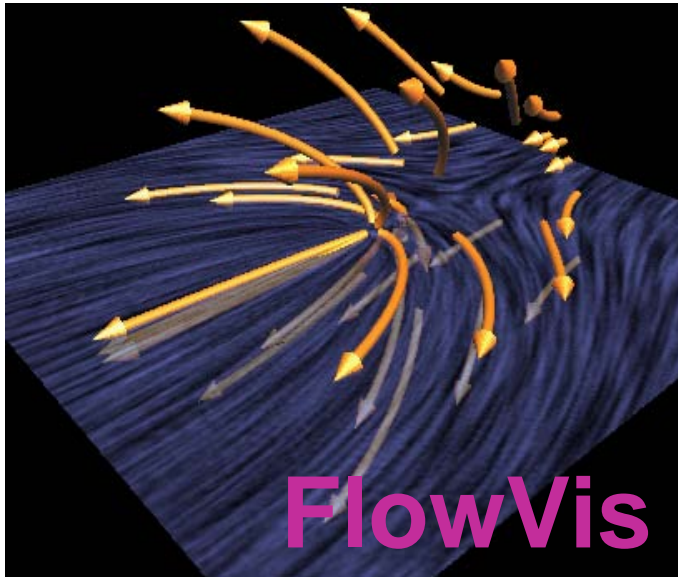
- 186.004 Visualisierung, VO
 - ◆ 3.0 ECTS, 2 hours
 - ◆ Eduard Gröller, Helwig Hauser
 - ◆ BDS/W, BMib/W, BZI/W, MCG/P
 - ◆ <http://www.cg.tuwien.ac.at/courses/Visualisierung/VO.html>

- 186.703 Visualisierung Übung, LU
 - ◆ 3.0 ECTS, 2 hours
 - ◆ Peter Rautek, Martin Illcik, Wolfgang Knecht, Eduard Gröller
 - ◆ BDS/W, BMib/W, BZI/W, MCG/W
 - ◆ <http://www.cg.tuwien.ac.at/courses/Visualisierung/LU.html>

- Exams:
 - ◆ oral
 - ◆ registration: <http://www.cg.tuwien.ac.at/courses/anmeldung/>

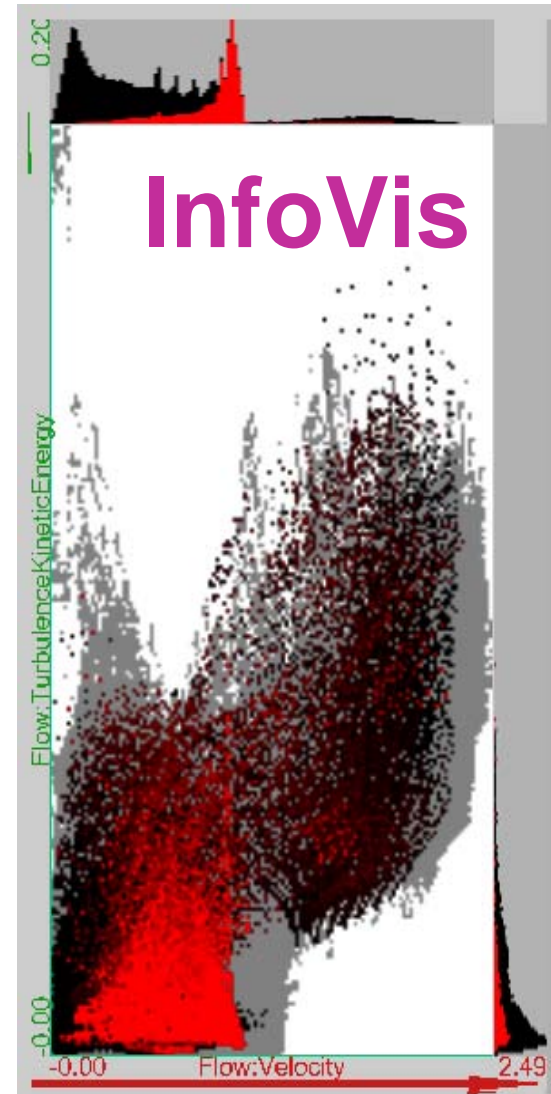


VolVis



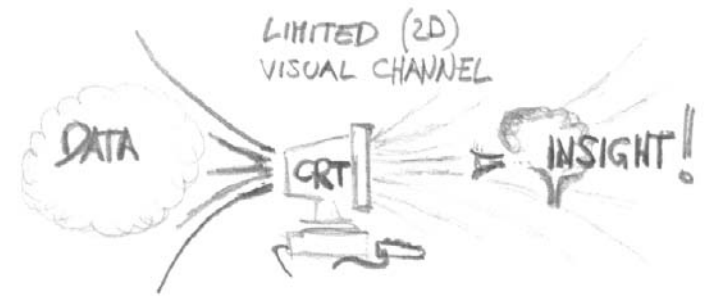
FlowVis

InfoVis



The purpose of computing is **insight**, not numbers

[R. Hamming, 1962]



■ Visualization:

- ◆ **Tool** to enable a **User** insight into **Data**
- ◆ to form a **mental vision, image, or picture** of (something not visible or present to the sight, or of an abstraction); to make **visible to the mind or imagination**

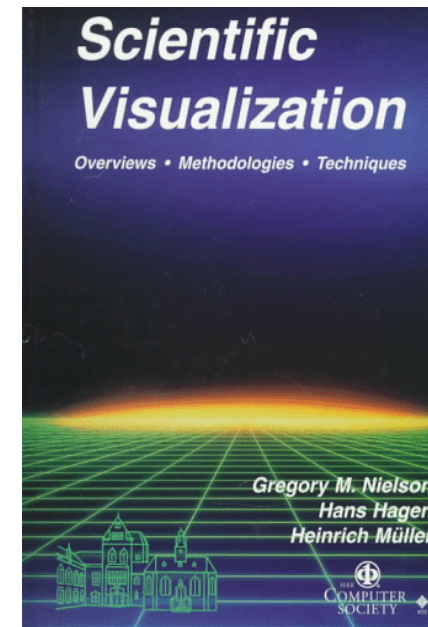
[Oxford Engl. Dict., 1989]

- ◆ **Computer Graphics,**
but not photorealistic rendering



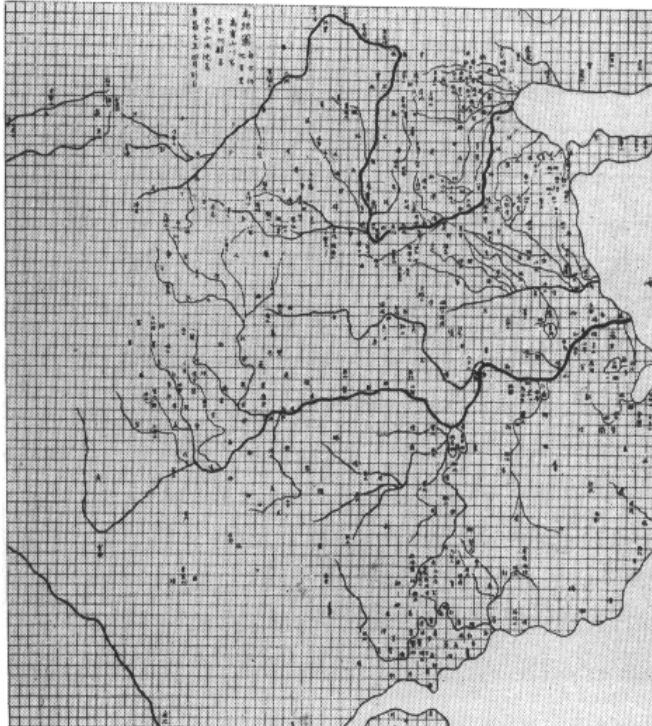
■ Background:

- ◆ Visualization = rather old
- ◆ Often an intuitive step: graphical illustration
- ◆ Data in ever increasing sizes \Rightarrow graphical approach necessary
- ◆ Simple approaches known from business graphics (Excel, etc.)
- ◆ Visualization = own scientific discipline since 20 years
- ◆ First dedicated conferences: 1990



1997

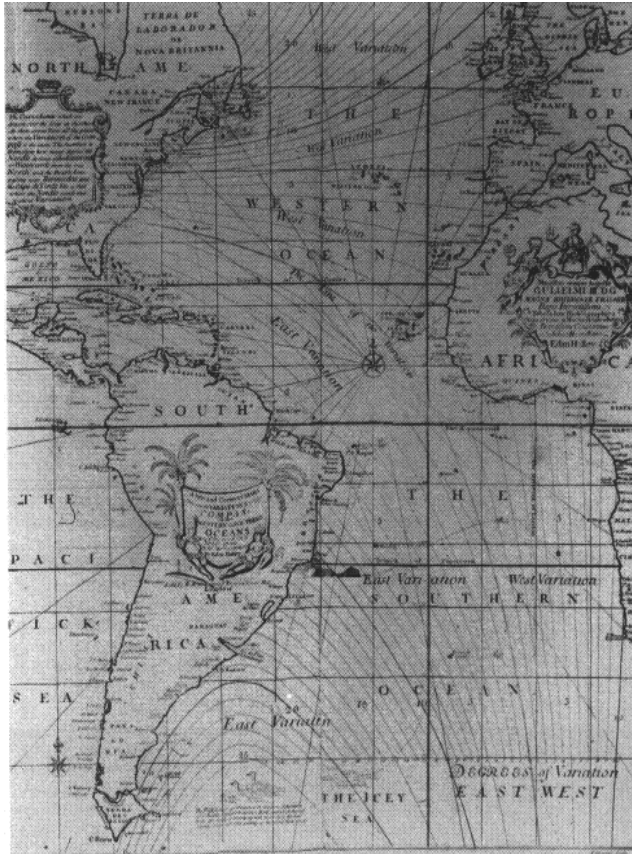




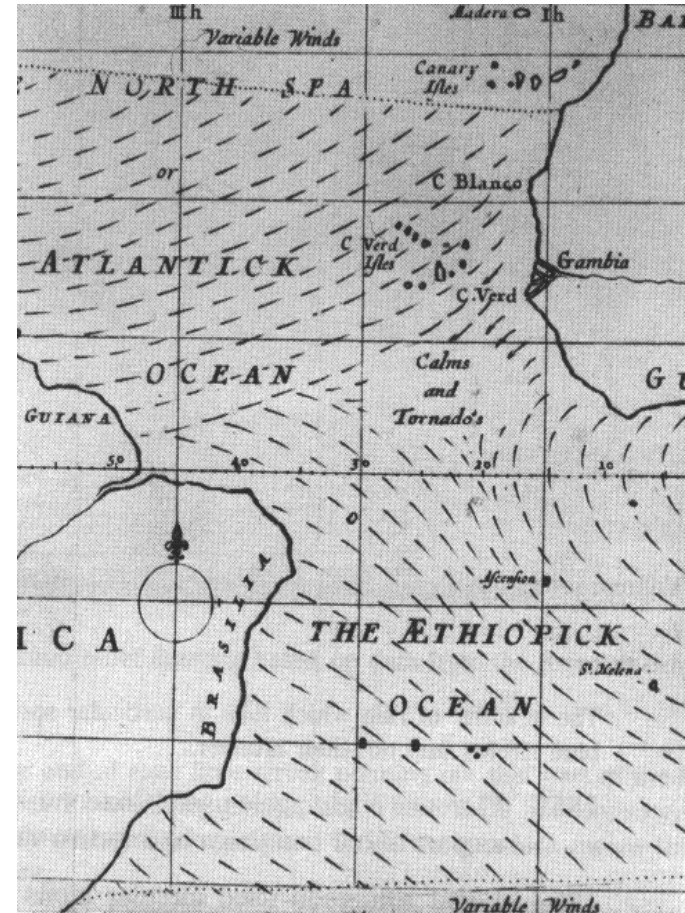
China, 1137

- Geographical Map using cartesian coordinates
- Grid with longitudinal and latitudinal lines





Isolines to visualize compass deviations



Wind flow visualization



Military Campaign of Napoleon

Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.
 Dessiné par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite. Paris, le 20 Novembre 1869.

Les nombres d'hommes présents sont représentés par les largeurs des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en travers des zones. Le rouge désigne les hommes qui entrent en Russie; le noir ceux qui en sortent. Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M. M. Chiers, de Legu, de Fezensac, de Chambray et le journal inédit de Jacob, pharmacien de l'Armée depuis le 28 Octobre. Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps du Prince Jérôme et du Maréchal Davoust qui avaient été détachés sur Minsk et Mohilow et qui rejoignent Orscha et Witebsk, avaient toujours marché avec l'armée.

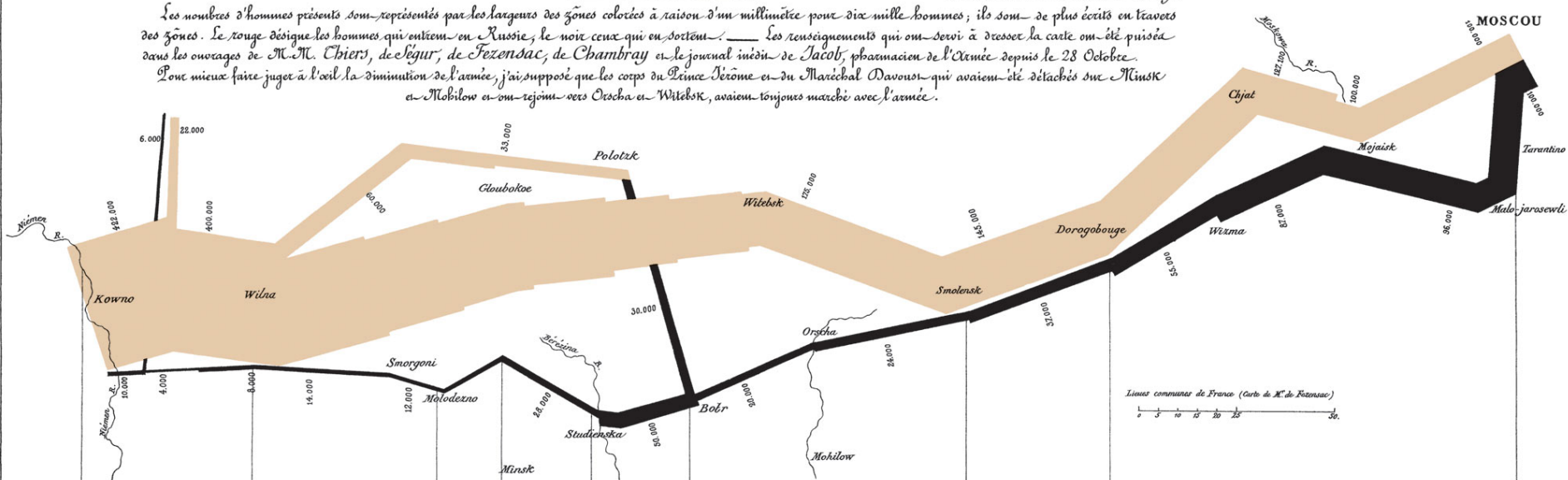
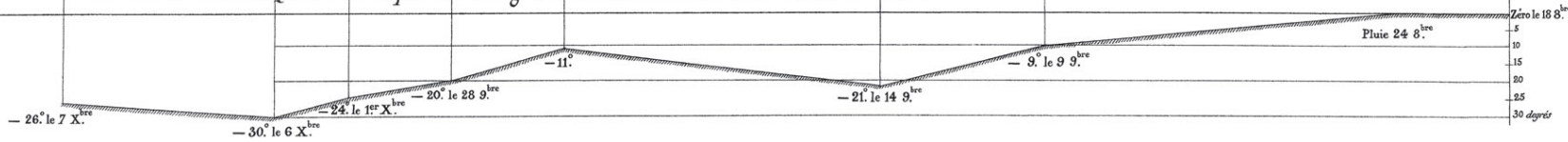


TABLEAU GRAPHIQUE de la température en degrés du thermomètre de Réaumur au dessous de zéro.



Les Cosaques passent au galop le Niéme gelé.

Auég. par Regnier, 8. Par. 5^{me} Marie St O^{me} à Paris.

Imp. Lith. Regnier et Desvres.

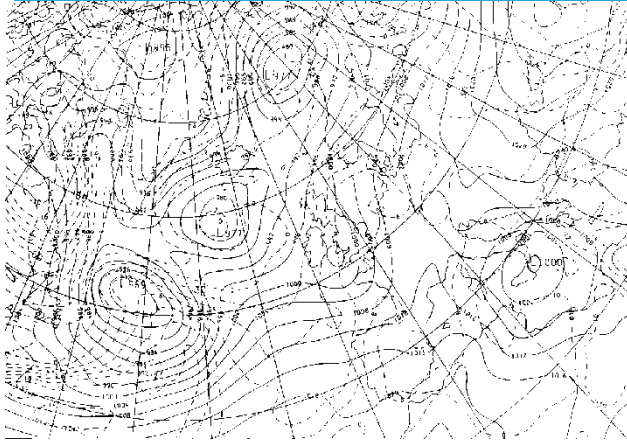
- Line thickness encodes troop strength





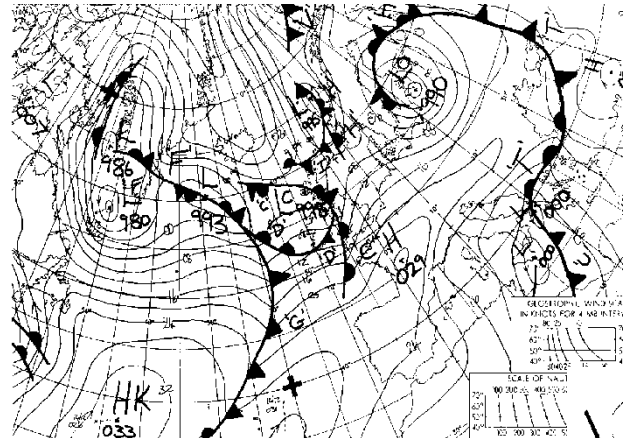
- Cartographic visualization
- Correlation between water supply and disease incidents detected



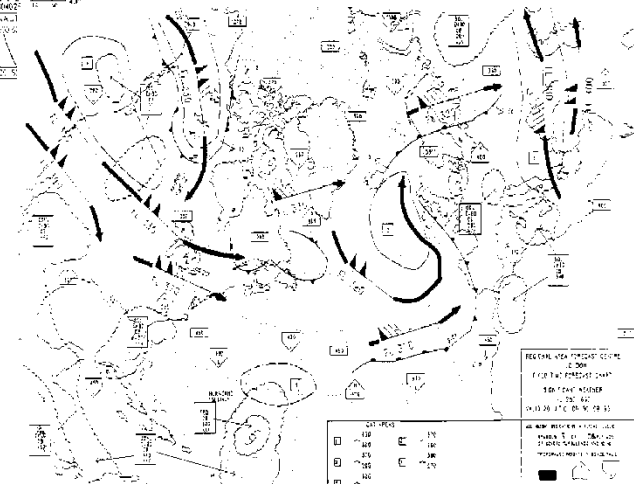


Weather fronts

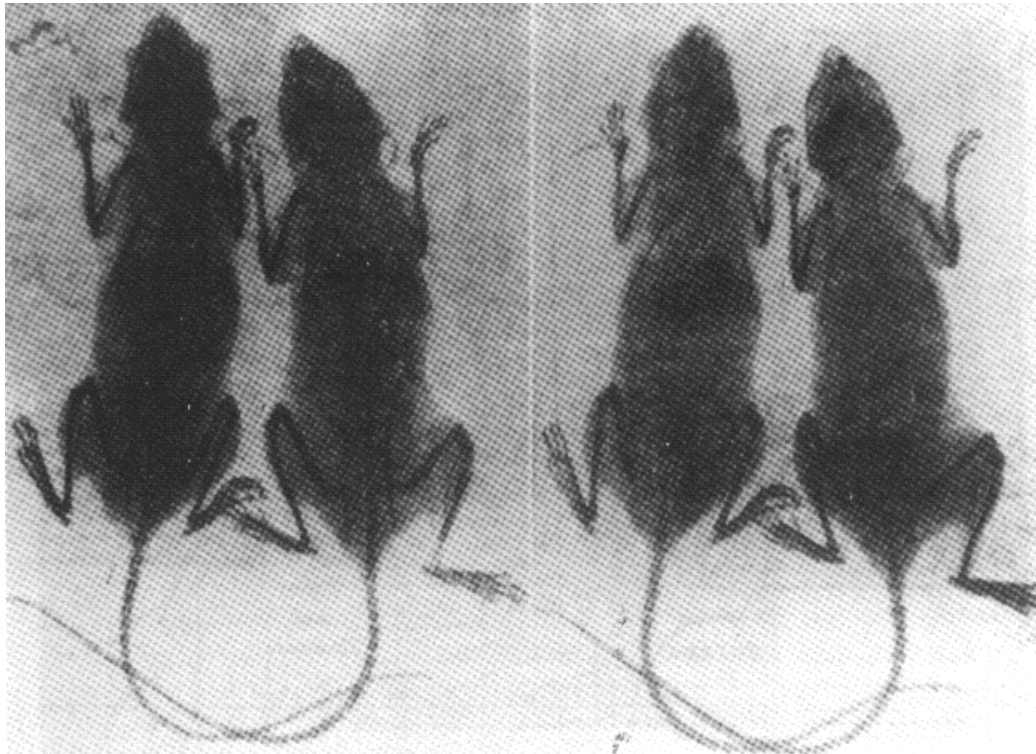
Map with iso-pressure lines



Map for pilots



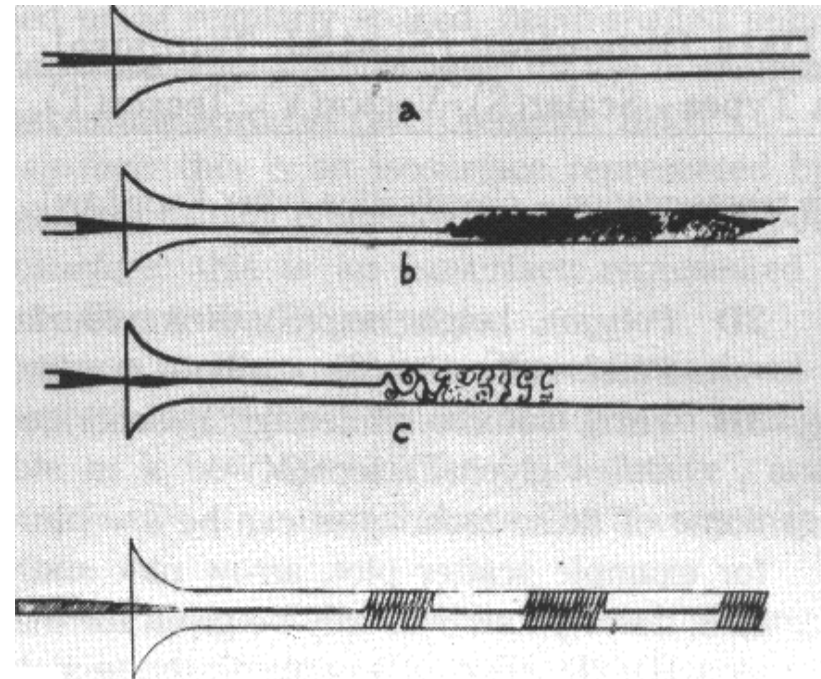
- X-rays (Wilhelm Röntgen, 1895)
- Stereo X-ray images (1896)

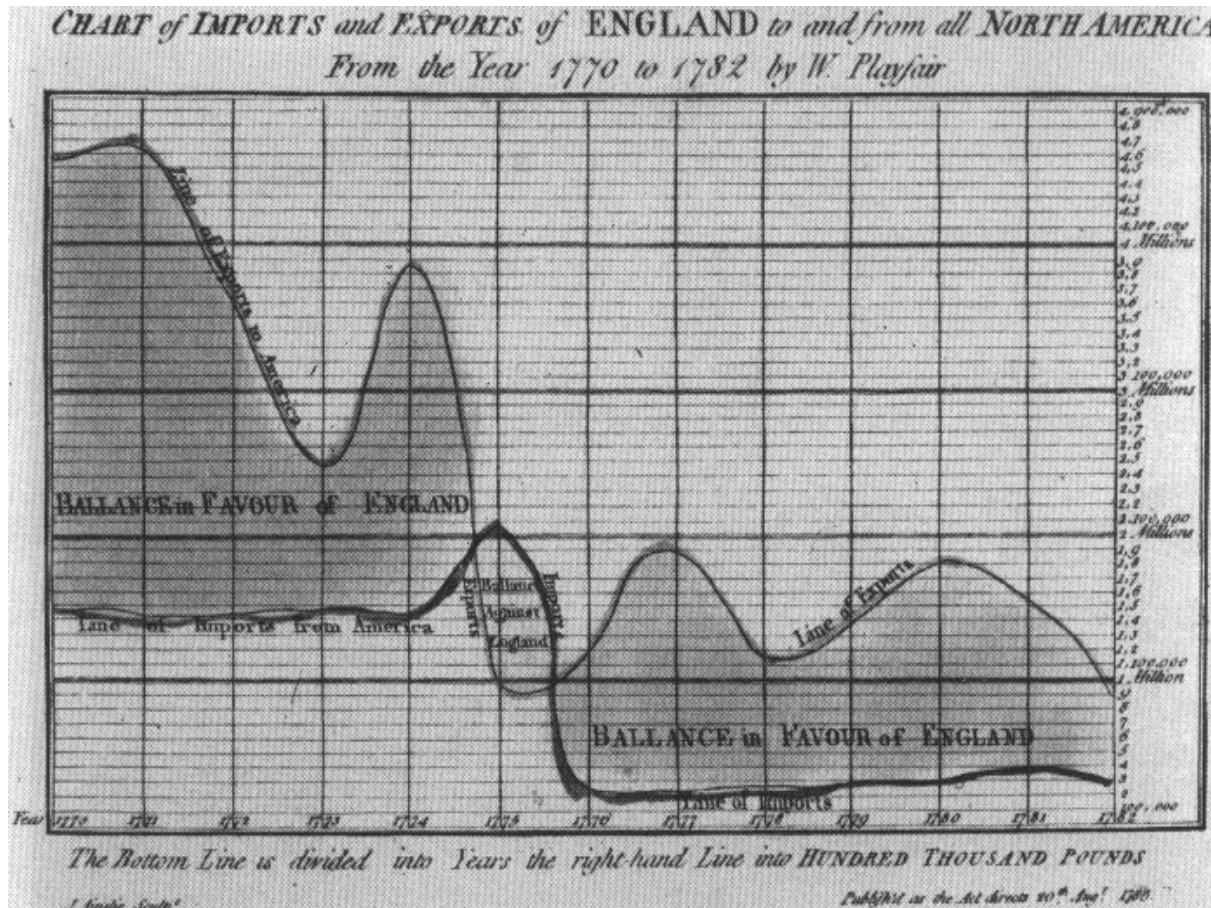


- X-ray tomography



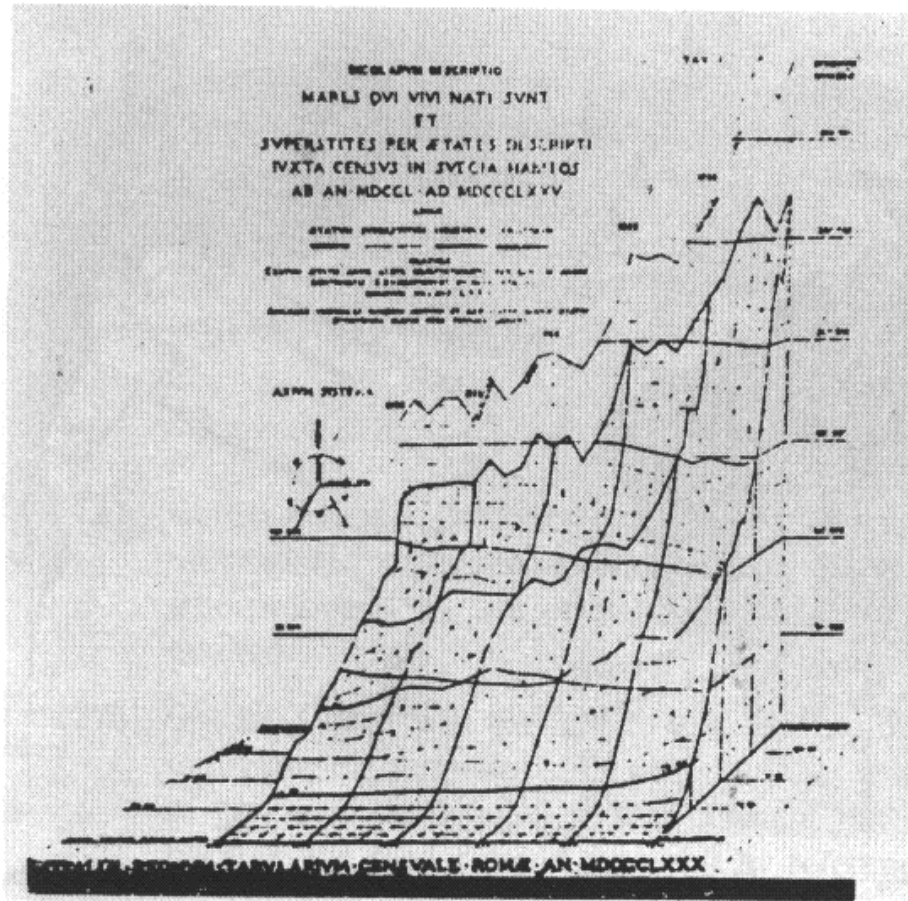
- Fixation of tufts, ribbons on
 - ◆ Aircraft in wind tunnels
 - ◆ Ship hull in fluid tanks
- Introduction of smoke particles (in wind tunnel)
- Introduction of dye (in fluids)





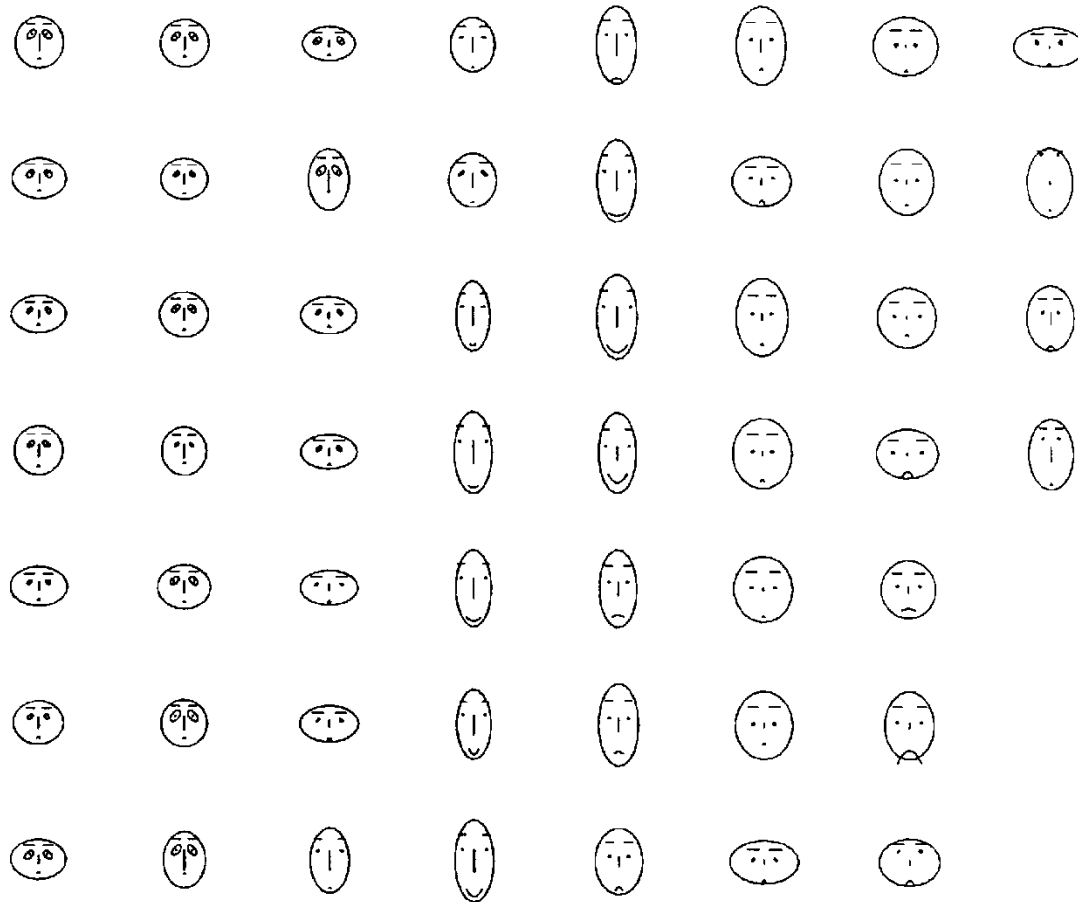
- W. Playfair, engl. econometrist, 1785
- Imports/Exports USA-England 1770-1782





- Population size Schweden 1750-1785
- Population as function of year and age group

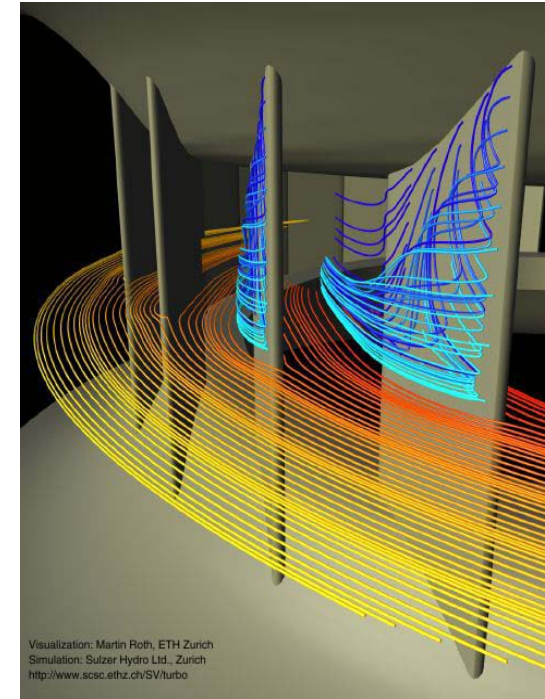




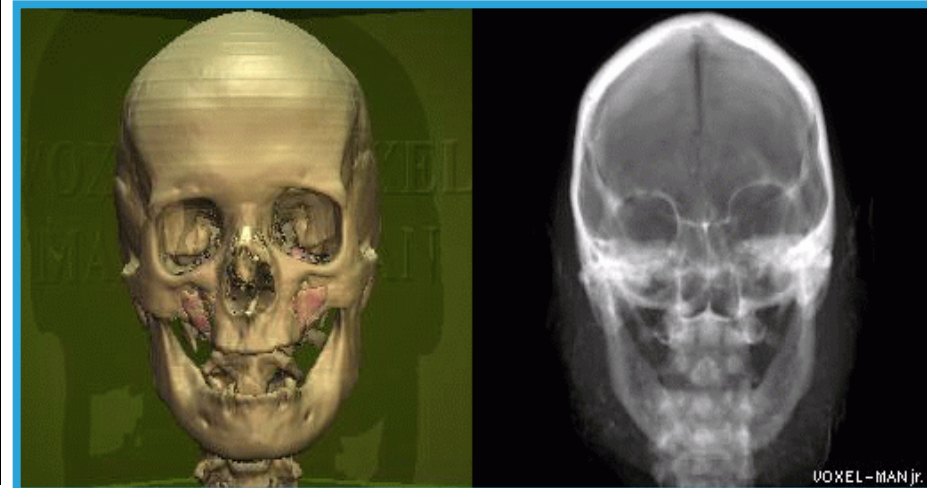
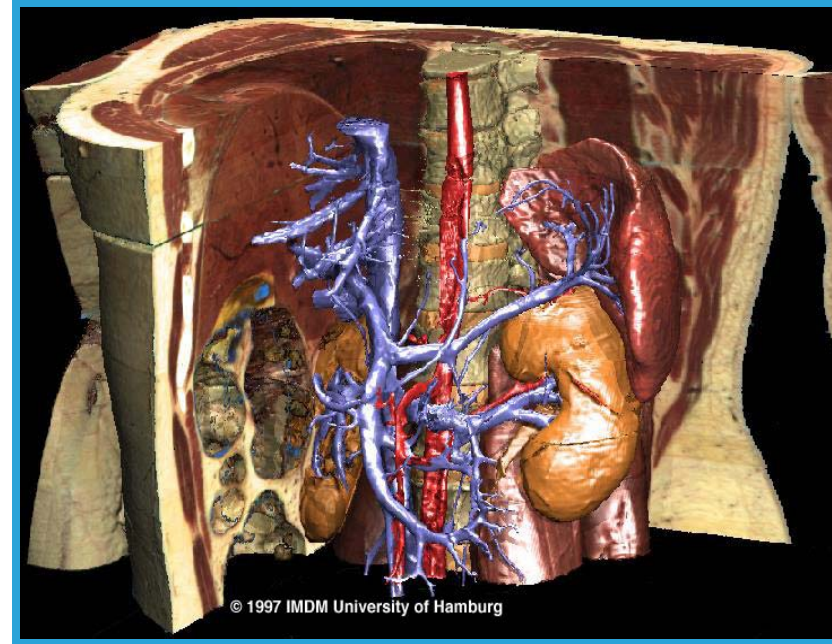
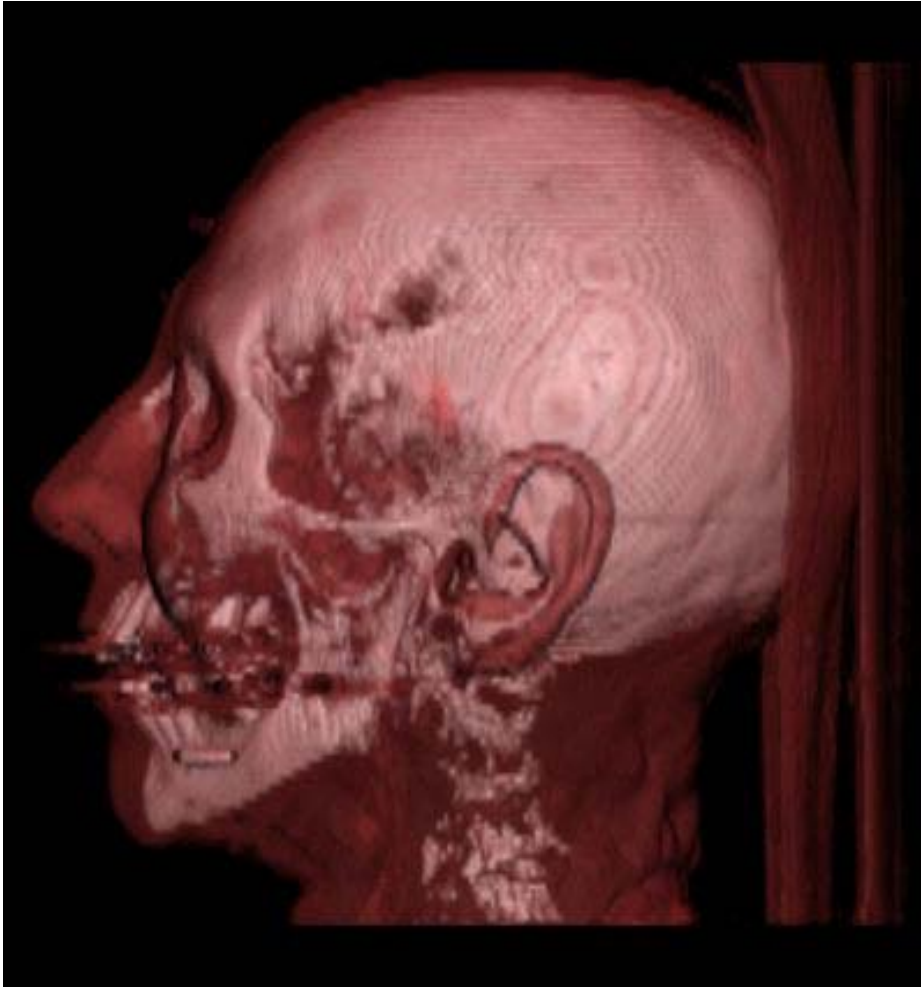
- H. Chernoff, 1973, 2D scatterplot
- Data characteristics encoded in geometric face features



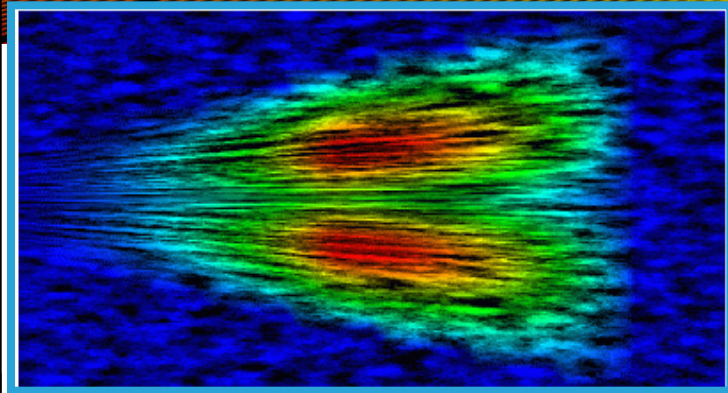
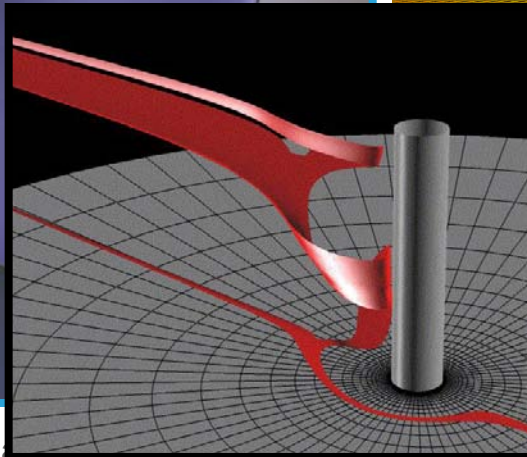
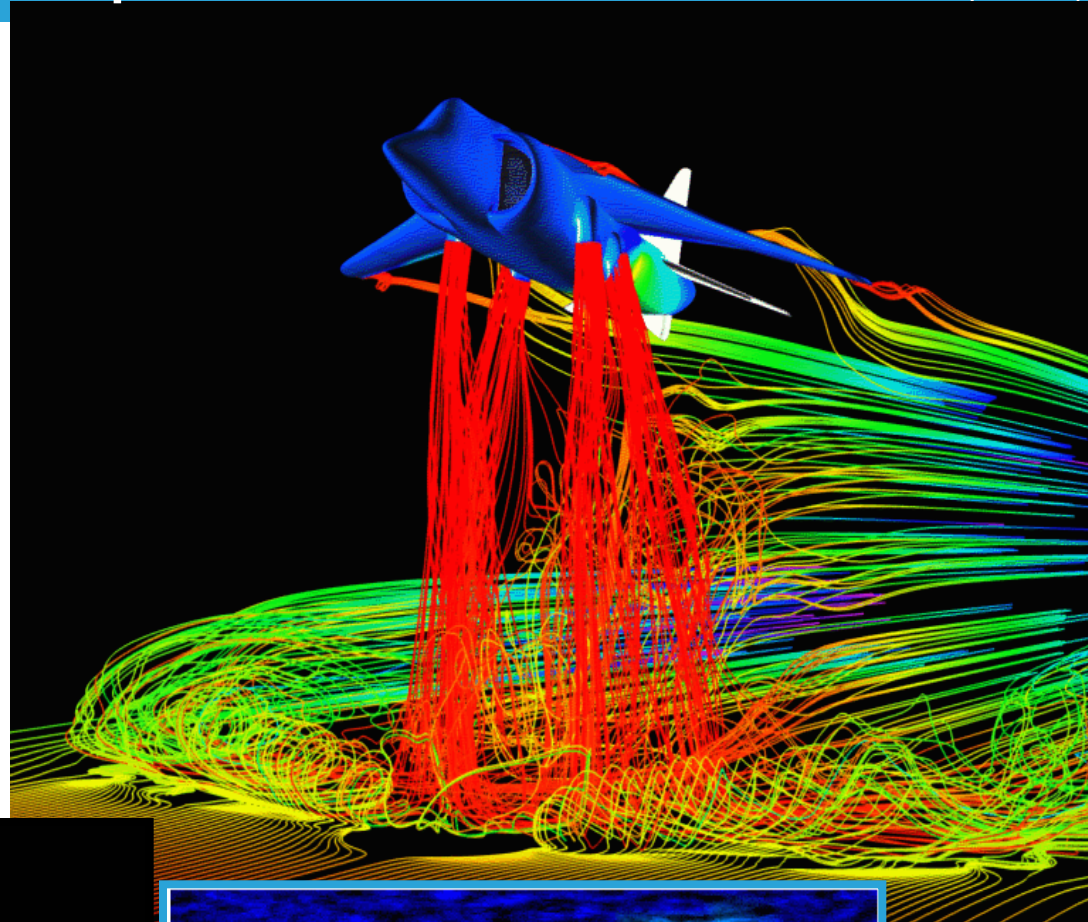
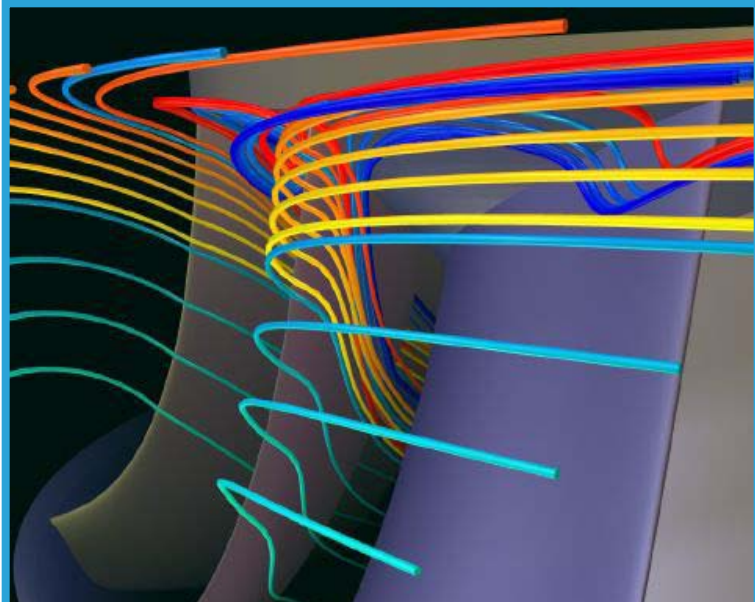
- Visualization of ...
 - ◆ Medical data \Rightarrow VolVis!
 - ◆ Flow data \Rightarrow FlowVis!
 - ◆ Abstract data \Rightarrow InfoVis!
 - ◆ GIS data
 - ◆ Historical data (archeologist)
 - ◆ Microscopic data (molecular physics),
Macroscopic data (astronomy)
 - ◆ Extrem large data sets
- etc. ...



■ Medical data



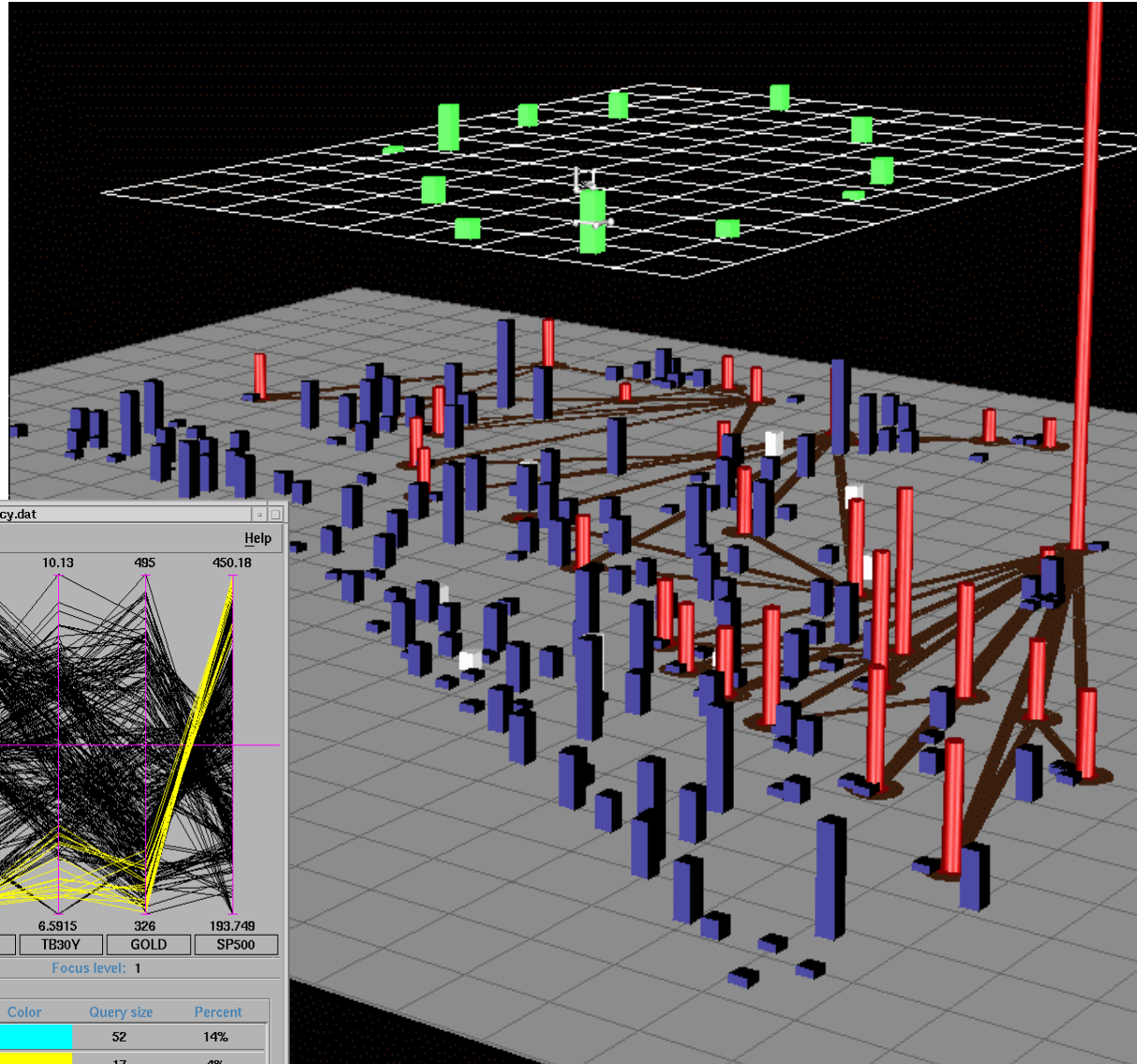
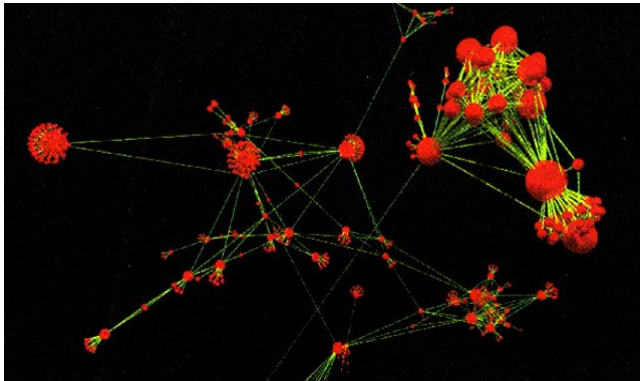
■ Flow data



Visualization: Martin Roth, ETH Zurich
Simulation: Sulzer Hydro Ltd., Zurich
<http://www.spsc.ethz.ch/SV/turbo>



■ Abstract data



Parallel Visual Explorer - .../usr/lpp/pve/samples/currency.dat

File Graph Scale Edges Query Variables Viewport Help

53 12 93 1.99245 0.7139 0.00007 9.03 10.13 495 450.18

1 1 85 1.38998 0.40485 0.00494 2.69 6.5915 326 193.749

WEEK MNTH YEAR BPS GDM YEN TB3M TB30Y GOLD SP500

Total size: 384 Undisplayed edges: No Impossible query: No Focus level: 1

Query

Creation mode
Pointer setting
Combiner

Summary	Name	Visible	Color	Query size	Percent
<input type="checkbox"/>	q2	<input type="checkbox"/>		52	14%
<input type="checkbox"/>	q1	<input type="checkbox"/>		17	4%



■ Visualization, ...

◆ ... to explore

- Nothing is known,
Vis. used for **data exploration**

◆ ... to analyze

- There are hypotheses, 
Vis. used for **Verification or Falsification**

◆ ... to present

- “everything” known about the data, 
Vis. used for **Communication of Results**



■ Three major areas

◆ Volume
Visualization

◆ Flow
Visualization

Scientific
Visualization

Inherent spatial
reference

3D

◆ Information
Visualization

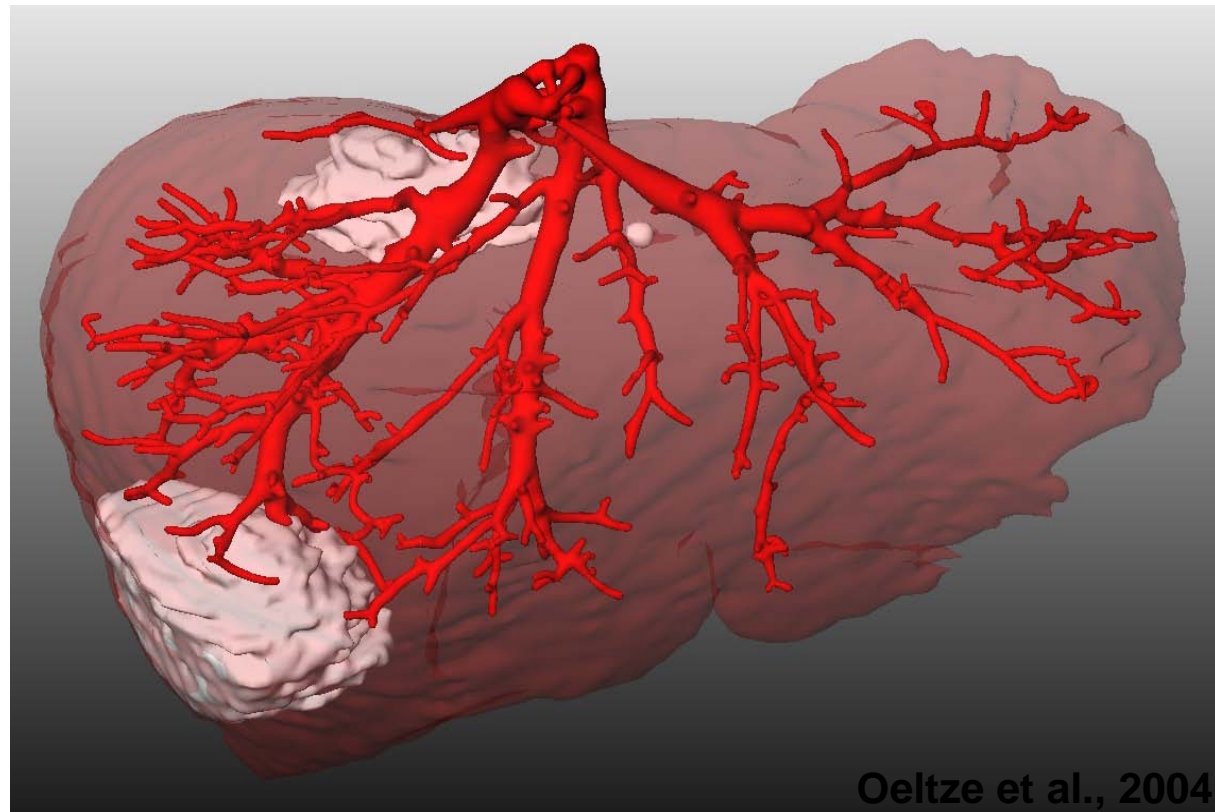
nD

Usually no spatial
reference



■ Medical Visualization in **Surgery Planning**

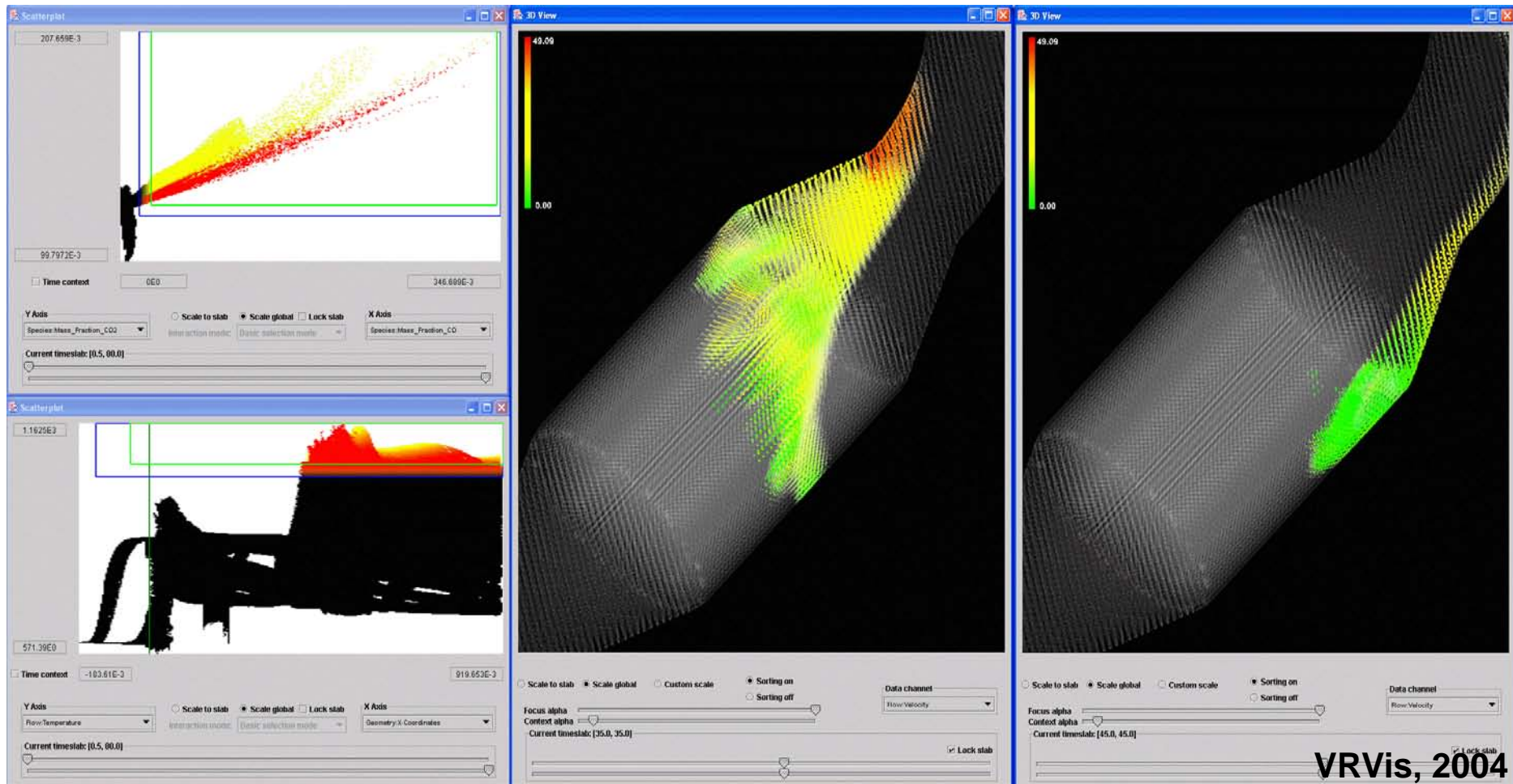
- Image:
Liver
(blood vessels,
tumors)



Oeltze et al., 2004



For DPF-Analysis (DPF: Diesel Particle Filter)



■ Visualization of Search-Results

- Image:
- document lengths
- frequencies
- etc.

User Query
(Enter words for different topics on different lines.)

osteoporosis
prevention
research

Run Search New Query Quit

Search Limit: 50 100 250 500 1000

Number of Clusters: 3 4 5 8 10

Mode: TileBars

Cluster Titles Backup

FR88513-0157
AP: Groups Seek \$1 Billion a Year for Aging Research
SJMN: WOMEN'S HEALTH LEGISLATION PROPOSED CF
AP: Older Athletes Run For Science
FR: Committee Meetings
FR: October Advisory Committees; Meetings
FR88120-0046
FR: Chronic Disease Burden and Prevention Models; Program
AP: Survey Says Experts Split on Diversion of Funds for AIDS
FR: Consolidated Delegations of Authority for Policy Developm
SJMN: RESEARCH FOR BREAST CANCER IS STUCK IN P

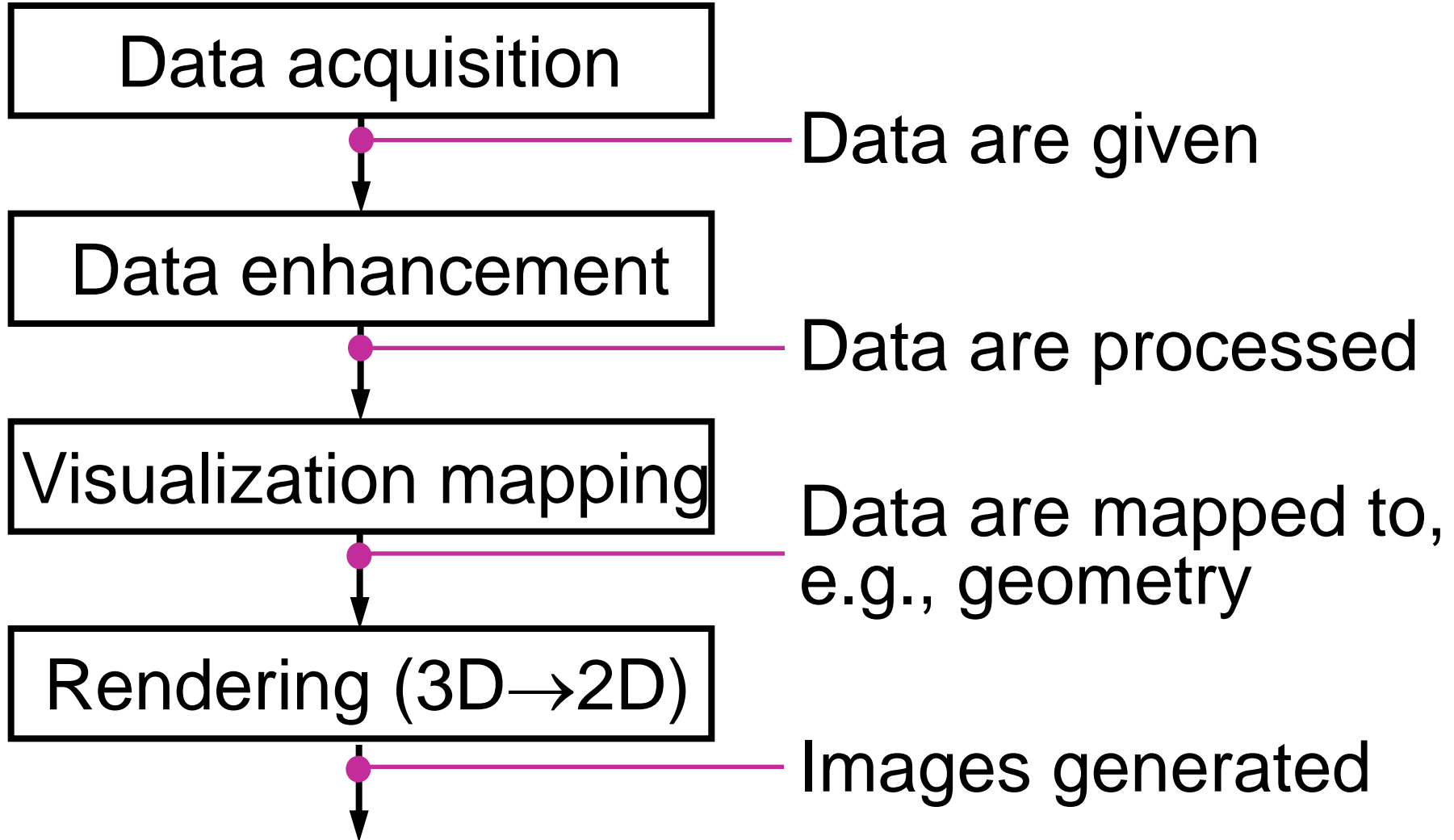
Hearst, 1995



Visualization Pipeline

Typical steps in the
visualization process





Data acquisition

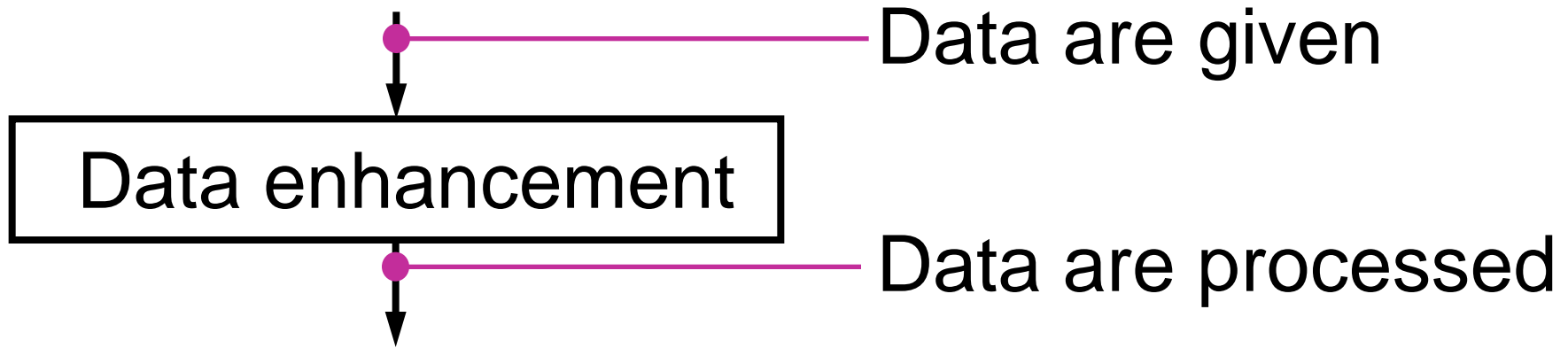


Data are given

■ Data acquisition

- ◆ Measurements, e.g., CT/MRI
- ◆ Simulation, e.g., flow simulation
- ◆ Modelling, e.g., game theory

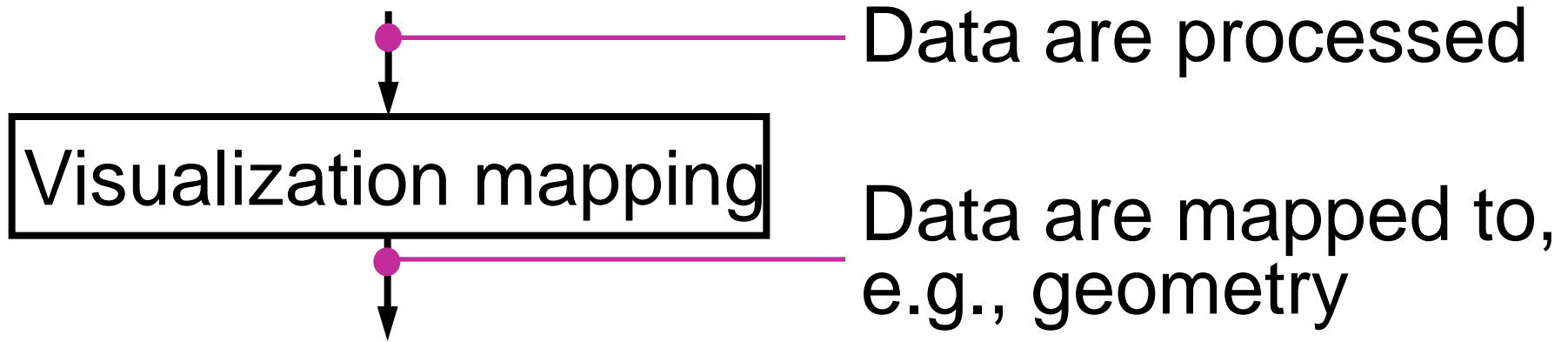




■ Data enhancement

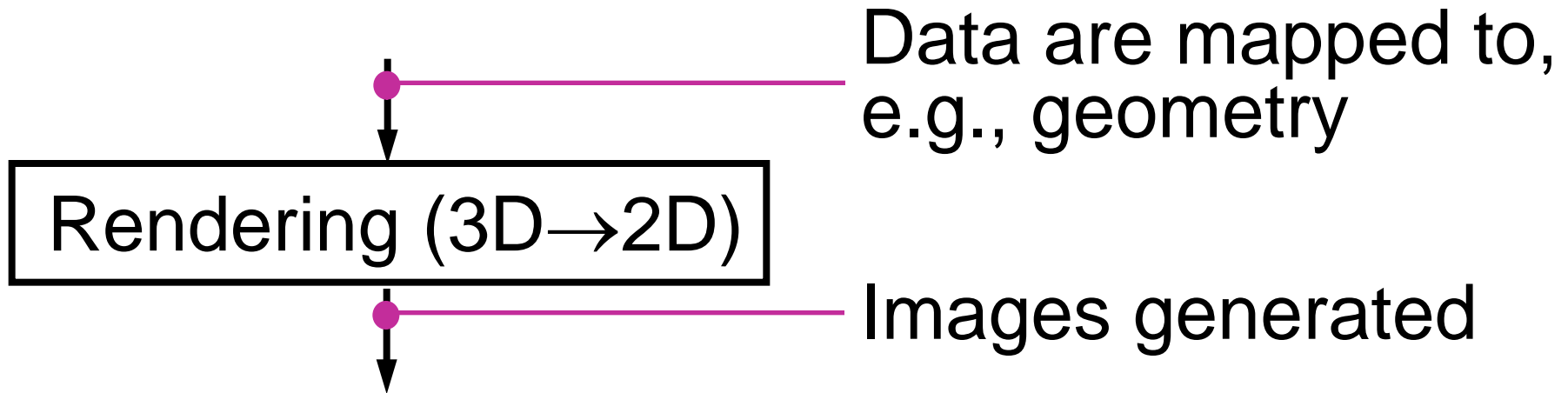
- ◆ Filtering, e.g, smoothing (noise suppression)
- ◆ Resampling, e.g., on a different-resolution grid
- ◆ Data Derivation, e.g., gradients, curvature
- ◆ Data interpolation, e.g., linear, cubic, ...





- Visualization mapping = data is renderable
 - ◆ Iso-surface calculation
 - ◆ Glyphs, Icons determination
 - ◆ Graph-Layout calculation
 - ◆ Voxel attributes: color, transparency, ...





- Rendering = image generation with Computer Graphics
 - ◆ Visibility calculation
 - ◆ Illumination
 - ◆ Compositing (combine transparent objects, ...)
 - ◆ Animation



SIMULATION DATA

Geometry: Surface Splines

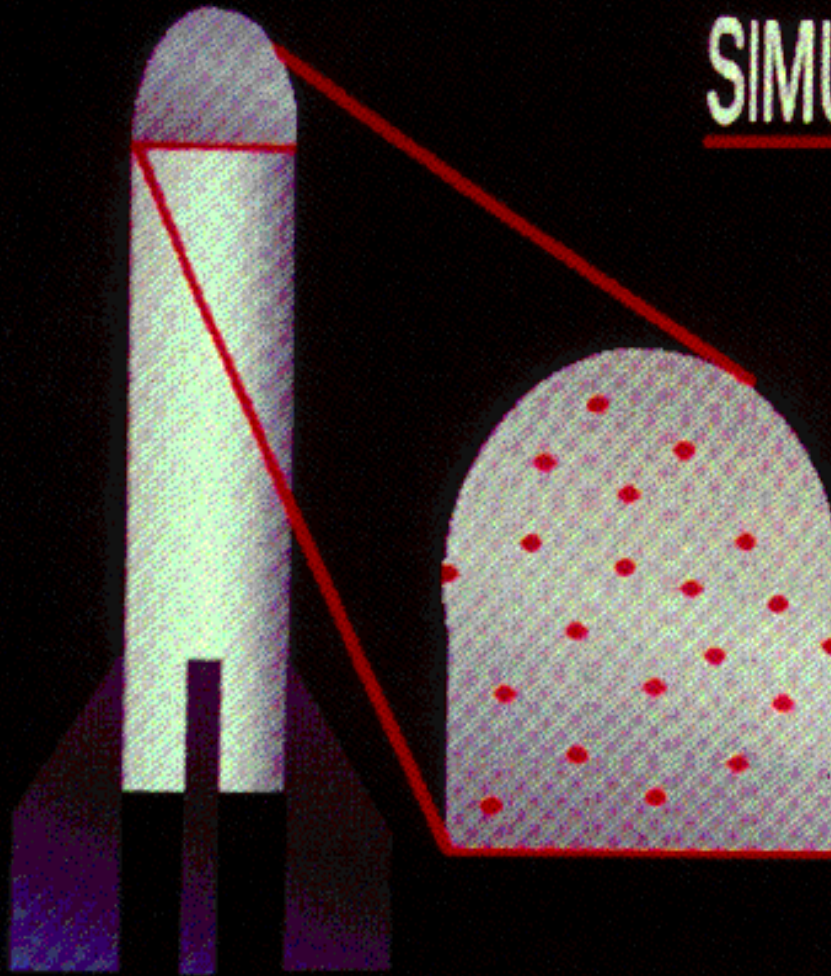
Sampling Points:

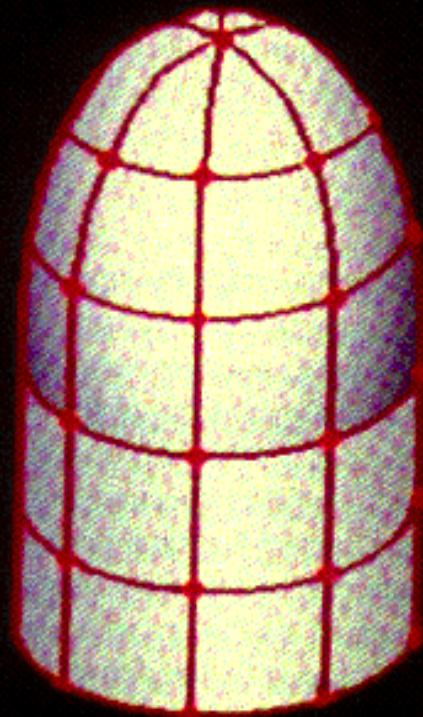
X, Y, Z

Temperature

Pressure

(irregular in space, time)



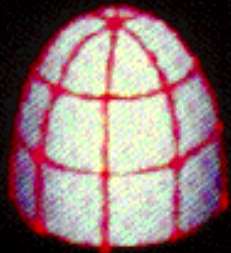


DERIVED DATA

Geometry: Polygonal Patches
(Vertices at X, Y, Z)

Data at Vertices:
Temperature, Pressure
(Regular in Time)

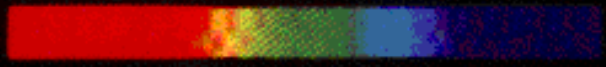
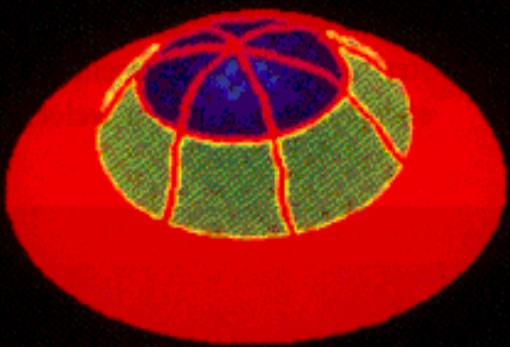




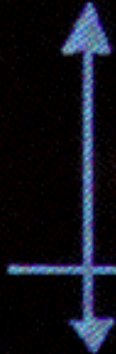
3D → 2D projection



Abstract
Visualization
Object



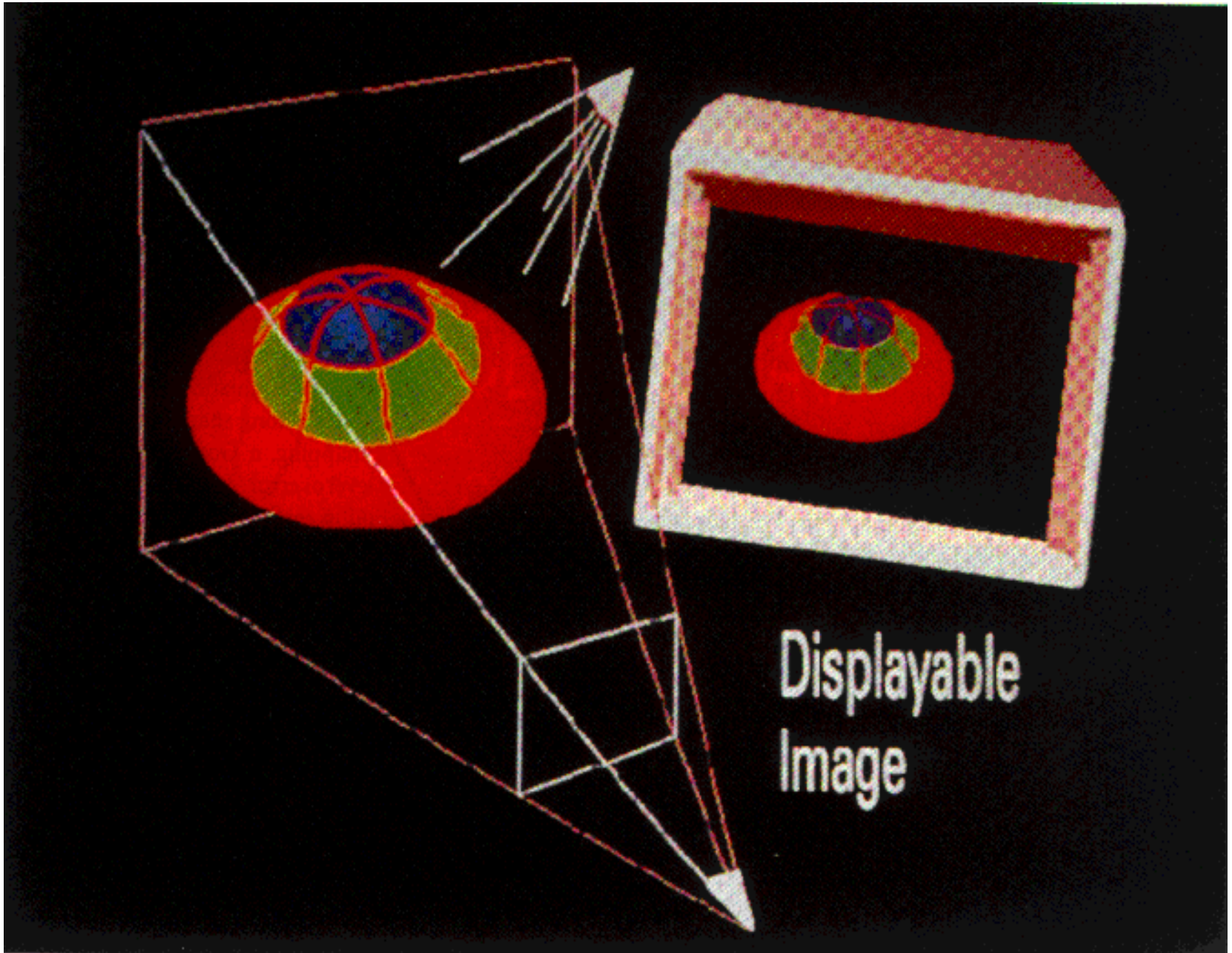
Temperature



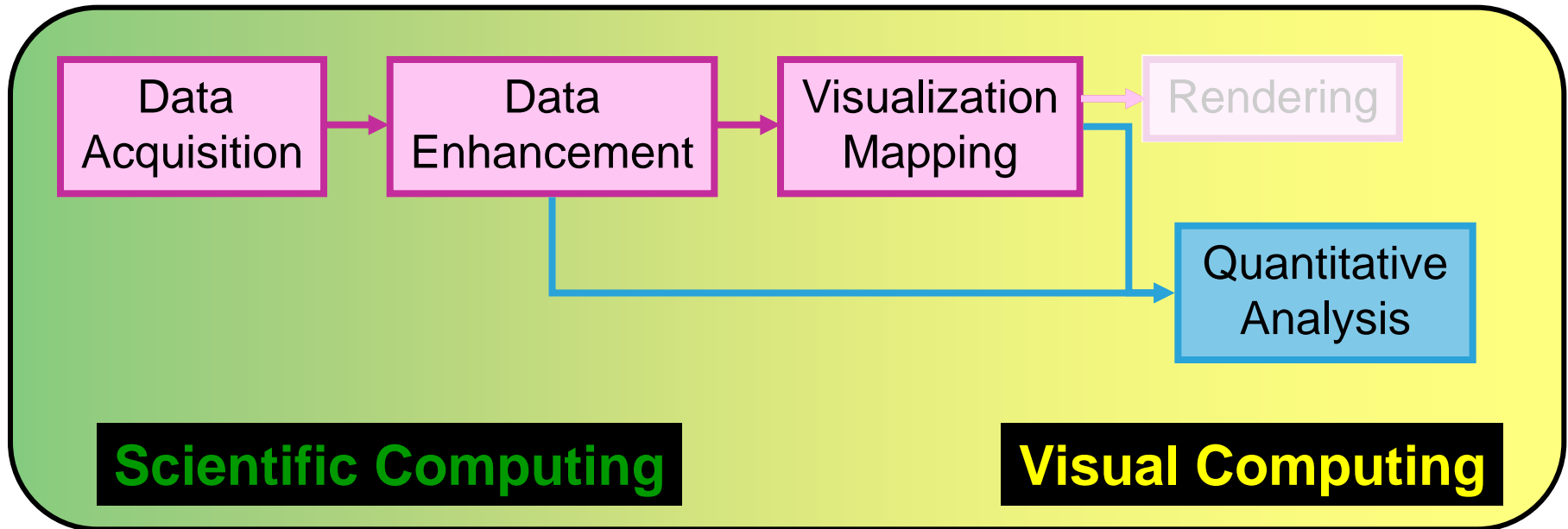
Pressure

0





Computational Sciences



■ Visual Computing

- ◆ Scientific visualization
- ◆ Computer vision
- ◆ Human computer interaction

