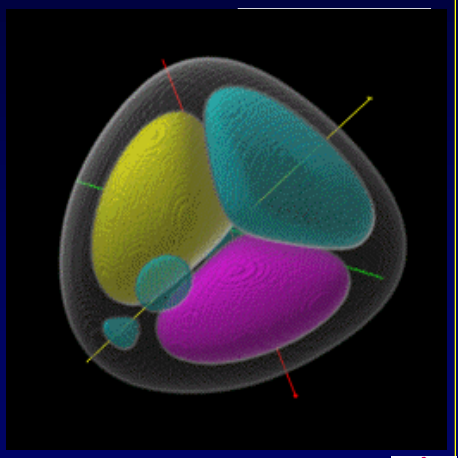
About 3D Visualization based on Volume Rendering



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Overview

... repeated in-between parts

Introduction

- aims of visualization
- examples
- important questions
- models for 3D rendering
- the visualization pipeline

Surface-fitting methods (SFM)

Direct volume rendering (DVR)

Final round-up

Intro – Visualization

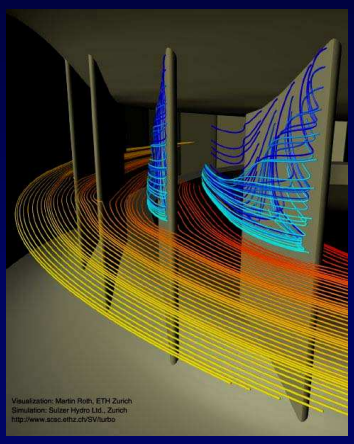
Aims of visualization:

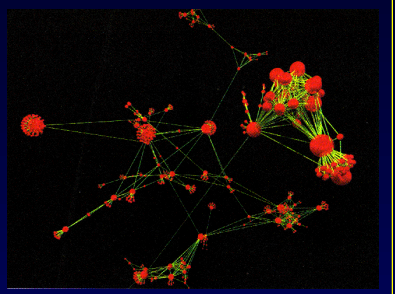
- to supply **insight** to the **data**
- to be a **user tool** for:
  - data **presentation**
  - data **analysis**
  - data **exploration**
- to provide skills to deal with **3D** information
- to help with **large data-sets**

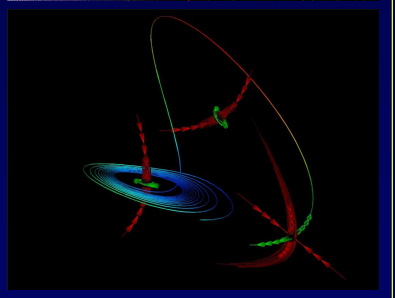
Intro – Visualization / Examples

InfoViz

ccw: **FlowViz, MedViz, DSViz,**







Intro – Visualization Questions

... later continued

Do I know the data?

- yes, “everything”: **presentation viz**
- no, but hypotheses: **analytical viz**
- no, nothing: **explorative viz**

What do I want to see?

- specific contents: **how characterized?**
- specific structures: **how visualized?**
- focus and context: **how integrated?**

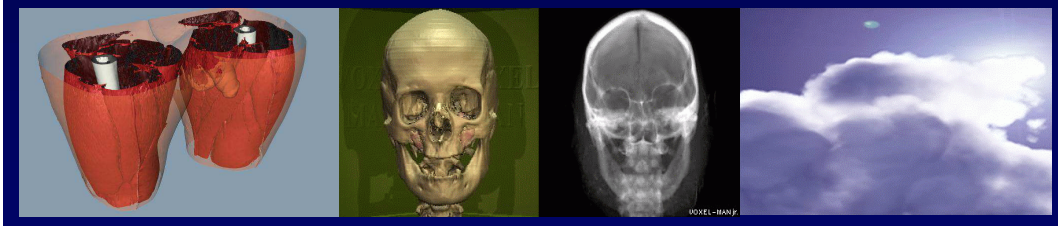
Intro – Models for 3D Rendering

Surface-fitting methods

- surfaces, objects
- optical aspects:
  - location of points
  - gradients
  - transparency

Direct volume rendering

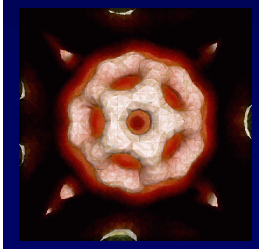
- clouds, fog, fire
- optical aspects:
  - attenuation
  - emission
  - shading

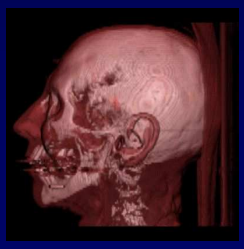


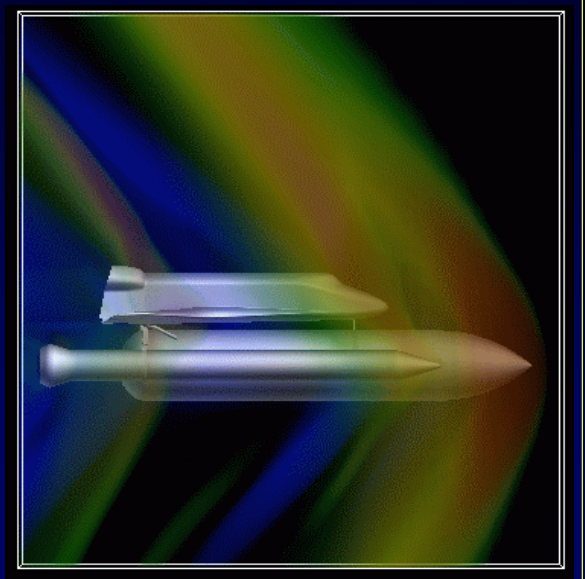
Intro – 3D Rendering Models (cont.)

Hybrid rendering = geometry + DVR

- ray casting
- compositing
- surfaces







Intro – The Visualization Pipeline

kD→nD	data acquisition, data enhancement	CT, MRI, ODE-Int.
nD→3D	visualization mapping	MC, TF
3D→2D	rendering	Tris., DVR

Overview (repeated)

Introduction
- the visualization pipeline

Surface-fitting methods (SFM)
- typical SFM-pipeline
- marching cubes
- examples

Direct volume rendering (DVR)

Final round-up

SFM – Typical SFM-Pipeline

k*2D→3D	stack of k slices (256^2) → resampled grid (256^3)
3D→3D	MC generates triangles
3D→2D	HW rendering of tris.

SFM – Marching Cubes

Assumptions:

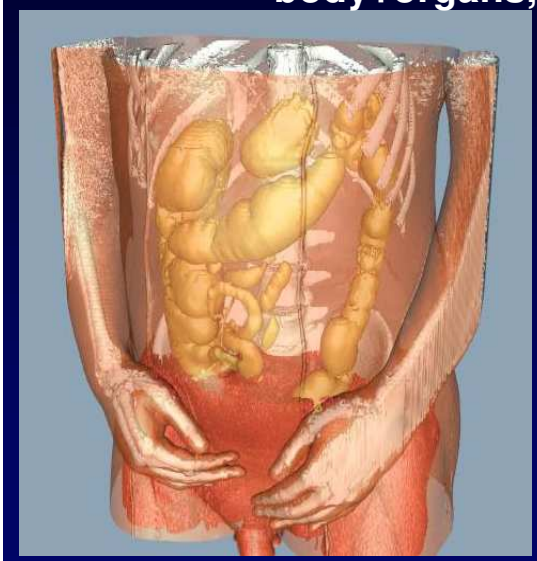
- scalar data, 3D domain, grid structure, iso-surfacing appropriate

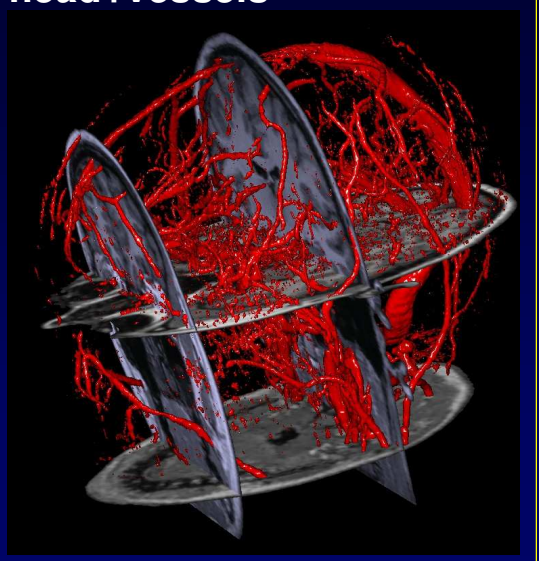
Approach in general:

- select proper iso-value
- FOR all cells: IF iso-surface passes thru:
  - compute surface triangles, queue them
- render all triangles

SFM – March. Cubes / Examples

body+organs, head+vessels





Overview (repeated)

Introduction

Surface-fitting methods (SFM)

Direct volume rendering (DVR)

- MIP: maximum-intensity projection
- MIP / examples
- ray casting + compositing
- examples

Final round-up

DVR – Maximum-Intensity Proj.

Assumptions:

- scalar importance values, 3D domain, proper reconstruction, MIP appropriate

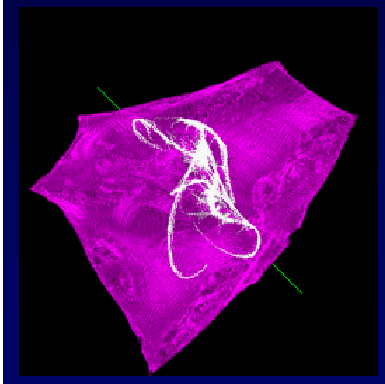
Approach in general:

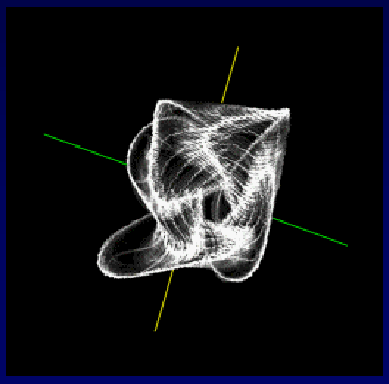
- FOR all pixels: get viewing-ray thru data:
  - STEP along ray: find maximum value
  - render after windowing

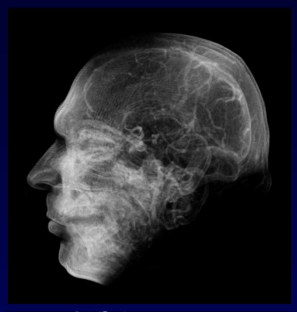
DVR – MIP / Examples

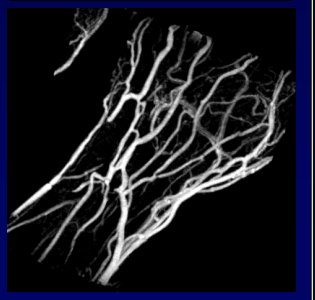
Head

ccw: Basin+Attr., Attr., Hand,









DVR – Ray Casting + Compositing

Assumptions:

- visual properties (color, opacity, etc.) by transfer function (TF), 3D domain, proper reconstruction, compositing appropriate

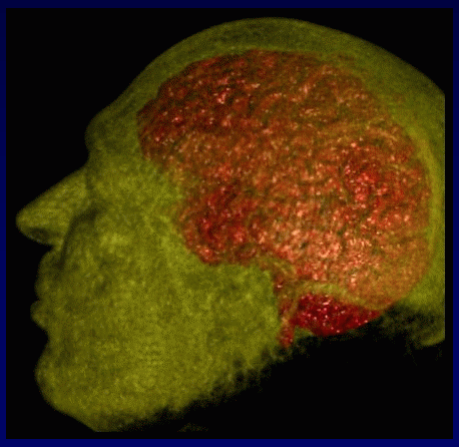
Approach in general:

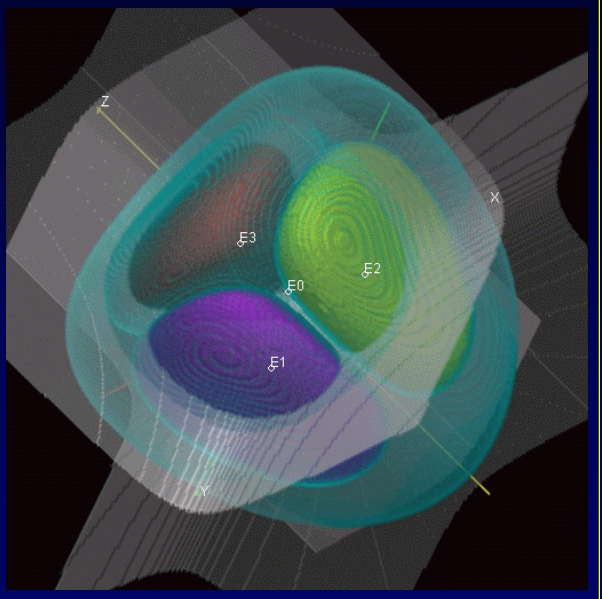
- FOR all pixels: get viewing-ray thru data:
  - STEP along ray back-to-front: composite:
    - updated pixel value = weighted sum (accord. to transparency/opacity, resp.) of old pixel value and current color

DVR – Volume Rendering

basins+LC$_{-1}$

ccw: **head+brain,**





Overview (repeated)

Introduction
- important questions

Surface-fitting methods (SFM)

Direct volume rendering (DVR)

Final round-up
- important questions recalled
- conclusions

Intro – Viz Questions (re-called)

What's the data about?

- input? formulas, samples?
- data prep.? sampling, filtering? rating, valuating?

What viz method to choose?

- SFM? surface-like data! sharp transitions of values!
- DVR? cloud-like data, real 3D!

Conclusions – why (not) 3D?

Going 3D (compared to 2D) means:

- one additional dimension of visualization, eases visualization mapping for nDim data
- utilizing natural metaphors (surfaces, etc.)

On the other hand:

- visualization becomes non-trivial, complex
- bottleneck rendering (3D→2D projection): occlusion, compression thru convolution

The END –
thank you very much!