King Abdullah University of Science and Technology KAUST

CS 247 – Scientific Visualization
Lecture 2: Introduction, Pt. 2

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Reading Assignment #1 (until Jan 29)

Sign up for piazza!

`http://piazza.com/kaust.edu.sa/spring2023/cs247`

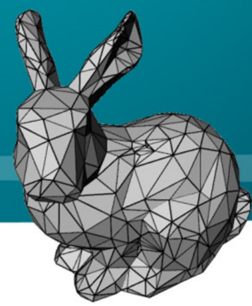
Read (required):

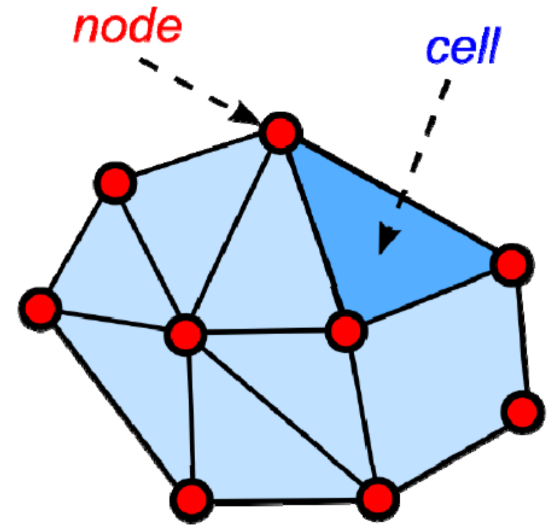
- Data Visualization book, Chapter 1
- Data Visualization book, Chapter 2 until 2.3 (inclusive)
- Download and look at:
  NIH/NSF Visualization Research Challenges report

  `http://tab.computer.org/vgtc/vrc/NIH-NSF-VRC-Report-Final.pdf`

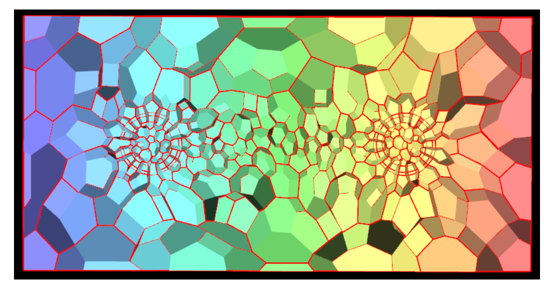
- Start familiarizing yourself with OpenGL if you do not know it !

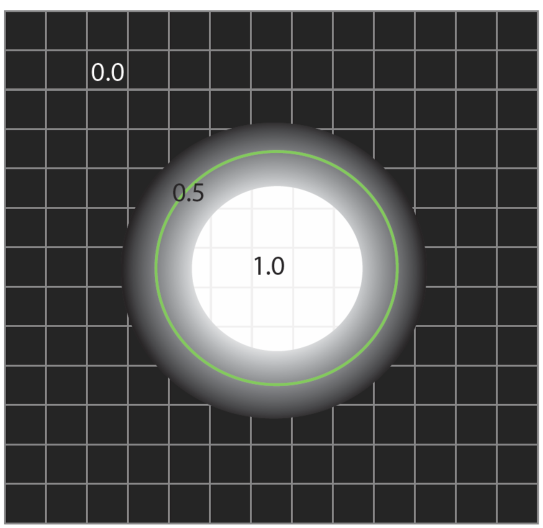
Syllabus (1)

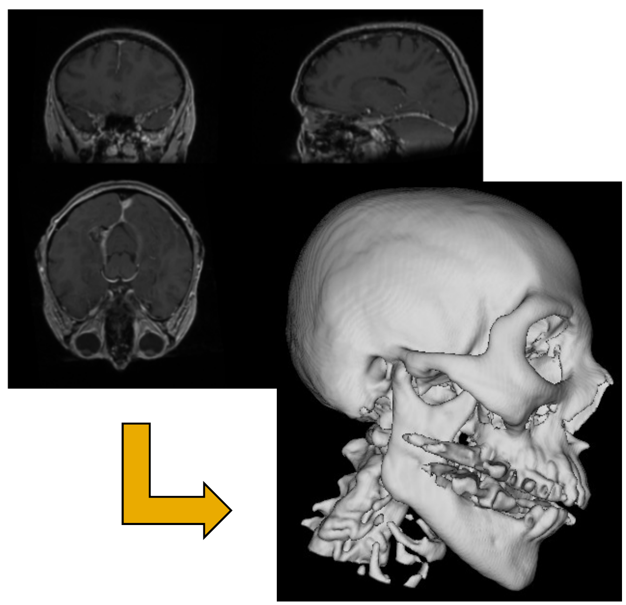


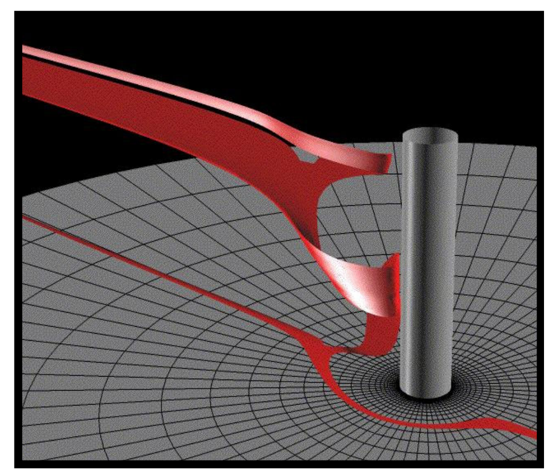


- Introduction
- Visualization basics, pipeline, and examples
- First scalar visualization example: iso-contouring
- GPU and computer graphics primer
- Data representation (grid types, data structures)

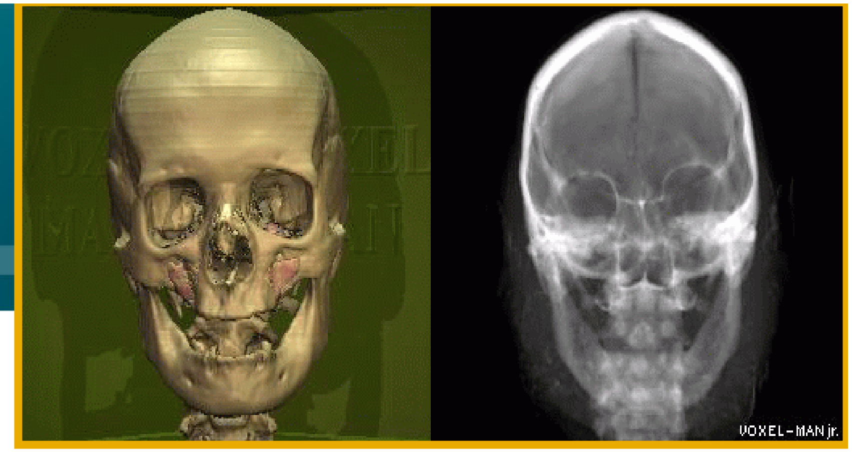






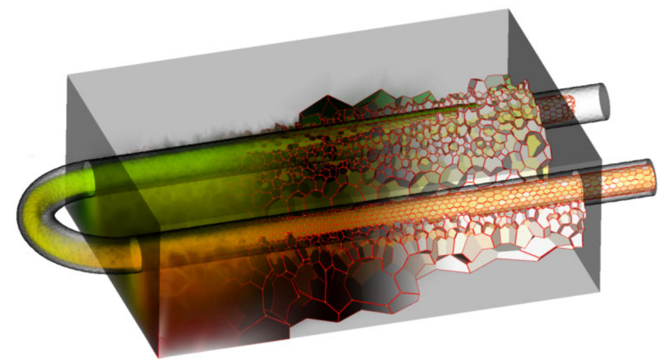


Syllabus (2)



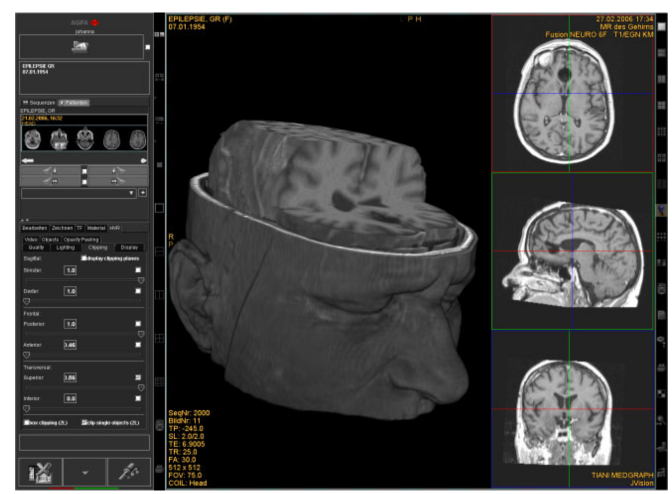
Scalar field visualization

- Iso-surface rendering
- Volume rendering
- Transfer functions
- Volume lighting
- Unstructured grid visualization



Applications

- Medical visualization
- Industrial CT (computed tomography)
- CFD (computational fluid dynamics) visualization of scalar quantities



Syllabus (3)

Vector field and flow visualization

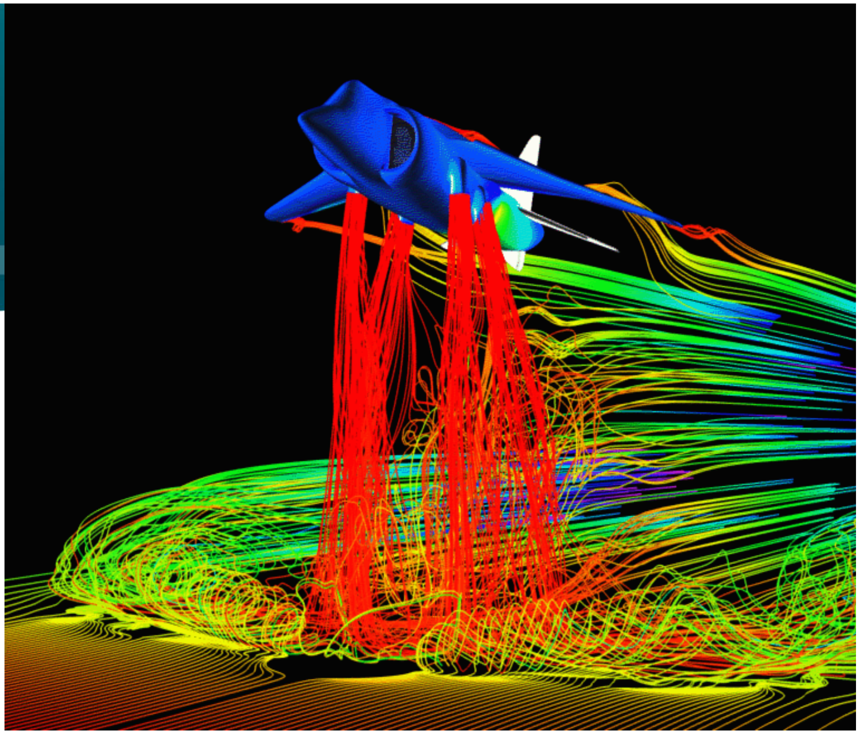
- Direct vs. indirect techniques
- Particle tracing
- Integral curves and surfaces
- Dense flow visualization techniques

Applications

- CFD flow visualization
- Weather visualization

If time permits

- Basic tensor visualization
- Visualization systems



What is Scientific Visualization? (1)

The use of computer graphics for the analysis and presentation of computed or measured scientific data

- Started in 1987 by the US National Science Foundation (NSF) in the “Visualization in Scientific Computing“ report

  `https://www.evl.uic.edu/pubs/1501`

- First IEEE Visualization conference 1990

- 2006 NIH/NSF Visualization Research Challenges Report, Chris Johnson et al.

  `http://tab.computer.org/vgtc/vrc/NIH-NSF-VRC-Report-Final.pdf`

“The purpose of computing is insight, not numbers“
Richard Hamming, 1971

What is Scientific Visualization? (2)

Visualization is a method of computing. It transforms the symbolic into the geometric, enabling researchers to observe their simulations and computations. Visualization offers a method for seeing the unseen. It enriches the process of scientific discovery and fosters profound and unexpected insights. In many fields it is already revolutionizing the way scientists do science.

McCormick, B.H., T.A. DeFanti, M.D. Brown,
Visualization in Scientific Computing,
Computer Graphics 21(6), November 1987

What is Scientific Visualization? (3)

The standard argument to promote scientific visualization is that today's researchers must consume ever higher volumes of numbers that gush, as if from a fire hose, out of supercomputer simulations or high-powered scientific instruments. If researchers try to read the data, usually presented as vast numeric matrices, they will take in the information at snail's pace. If the information is rendered graphically, however, they can assimilate it at a much faster rate.

R.M. Friedhoff and T. Kiely,
The Eye of the Beholder,
Computer Graphics World 13(8), pp. 46-, August 1990

What is Scientific Visualization? (4)

The use of computer imaging technology as a tool for comprehending data obtained by simulation or physical measurement by integration of older technologies, including computer graphics, image processing, computer vision, computer-aided design, geometric modeling, approximation theory, perceptual psychology, and user interface studies.

R.B. Haber and D. A. McNabb,

Visualization Idioms: A Conceptual Model for Scientific Visualization Systems,
Visualization in Scientific Computing,
IEEE Computer Society Press 1990.

What is Scientific Visualization? (5)

Scientific Visualization is concerned with exploring data and information in such a way as to gain understanding and insight into the data. The goal of scientific visualization is to promote a deeper level of understanding of the data under investigation and to foster new insight into the underlying processes, relying on the humans' powerful ability to visualize. In a number of instances, the tools and techniques of visualization have been used to analyze and display large volumes of, often time-varying, multidimensional data in such a way as to allow the user to extract significant features and results quickly and easily.

K.W. Brodlie, L.A. Carpenter, R.A. Earnshaw, J.R. Gallop, R.J. Hubbard, A.M. Mumford, C.D. Osland, P. Quarendon, ***Scientific Visualization, Techniques and Applications**, Springer-Verlag, 1992.*

What is Scientific Visualization? (6)

Scientific data visualization supports scientists and relations,

to prove or disprove hypotheses, and discover new phenomena

using graphical techniques.

The primary objective in data visualization is to gain insight into

an information space by mapping data onto graphical primitives.

H. Senay and E. Ignatius,
A Knowledge-Based System for Visualization Design,
IEEE Computer Graphics and Applications, pp. 36-47, November 1994

Thank you.

Thanks for material

- Helwig Hauser
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- Philipp Muigg
- Christof Rezk-Salama