

CS 247 – Scientific Visualization

Lecture 1: Introduction

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Lecture Overview



Goals

- Basics: Learn the most important techniques in scientific visualization
- Practice: Implement scalar and vector/flow field visualization techniques in OpenGL

Time and location

- Sunday/Wednesday, 10:00 – 11:30, Bldg 9, Room 3123.
- We'll do some lectures on Tuesday, 14:30 – 16:00

Course webpage:

https://vccvisualization.org/CS247_Scientific_Visualization/

Contact

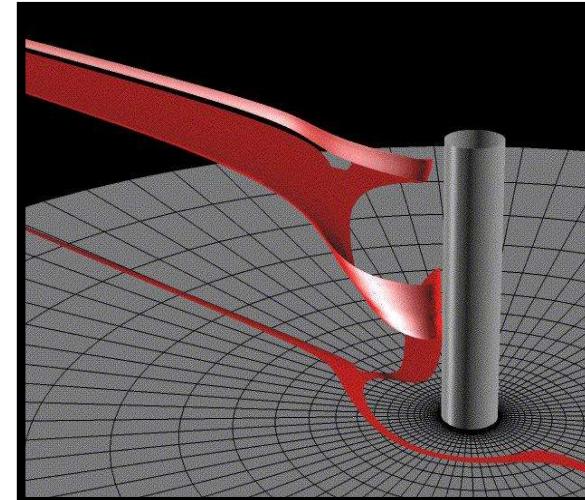
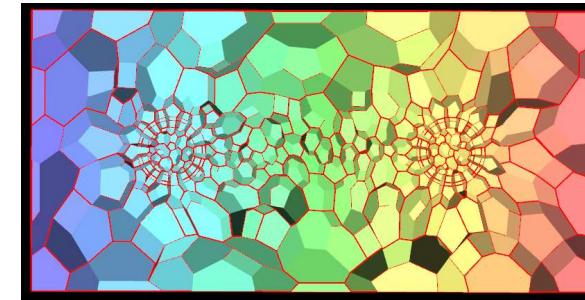
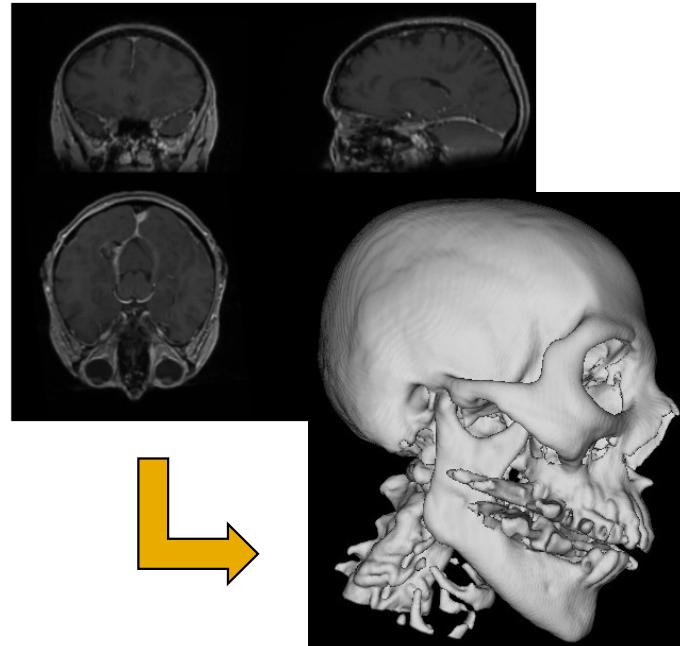
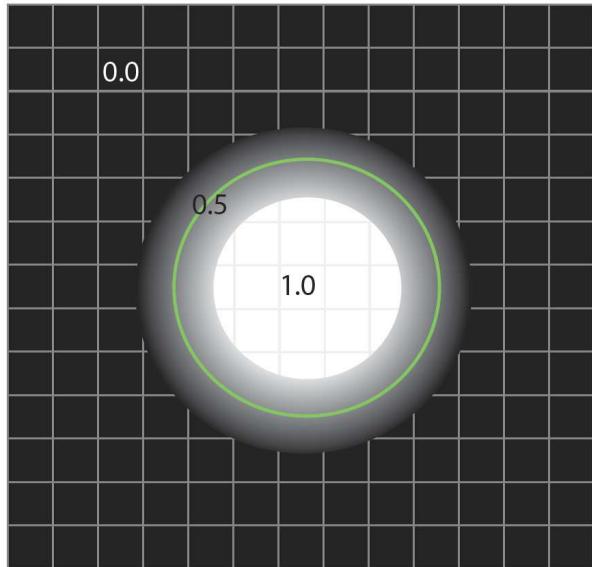
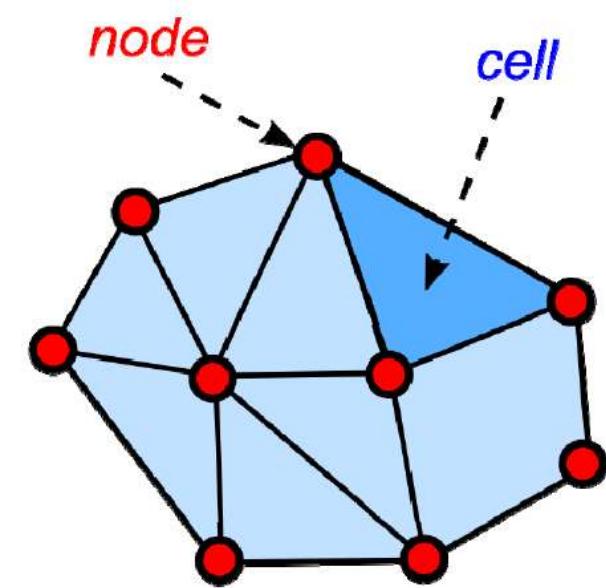
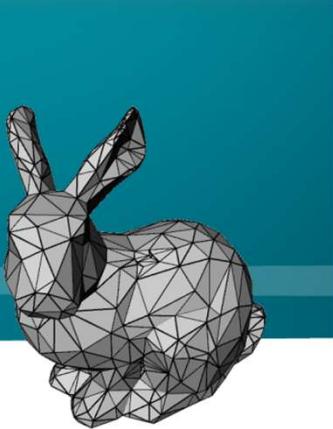
- Markus Hadwiger `markus.hadwiger@kaust.edu.sa`
- Programming assignments `kaust.cs247@gmail.com`
 - Alberto Jaspe `alberto.jaspe@kaust.edu.sa`
 - Julio Rey Ramirez `julio.reyramirez@kaust.edu.sa`

Prerequisites

- **C/C++ programming**, computer graphics, linear algebra, multi-variable calculus
- OpenGL experience (a basic graphics course, ...) very helpful !

Syllabus (1)

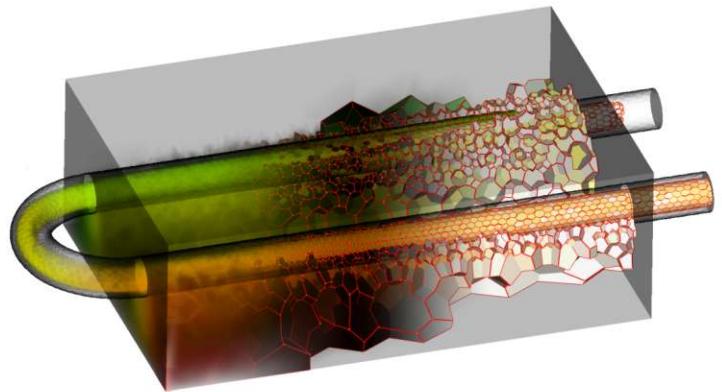
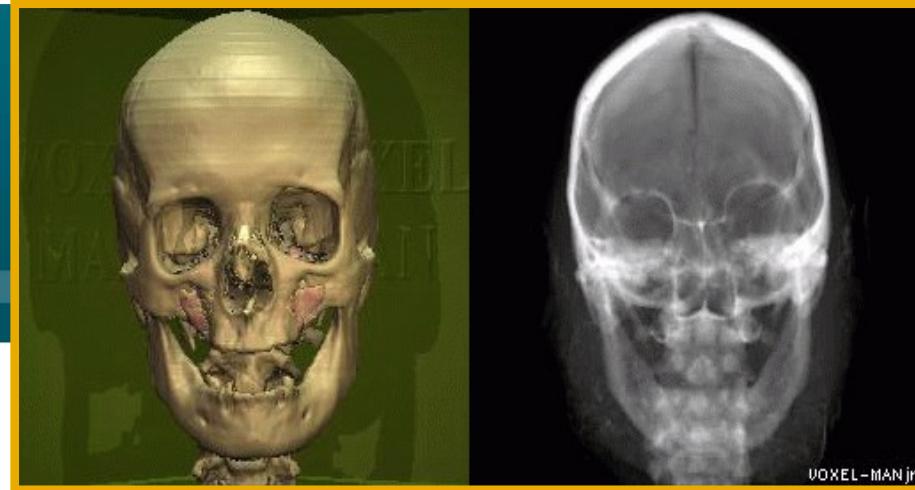
- Introduction
- Visualization basics, pipeline, and examples
- First scalar visualization example: iso-contouring
- GPU and computer graphics primer
- Data representation (grid types, data structures)



Syllabus (2)

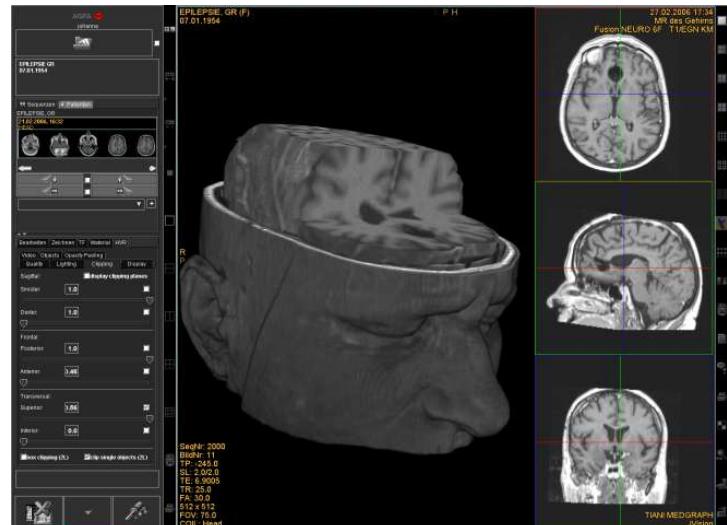
Scalar field visualization

- 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

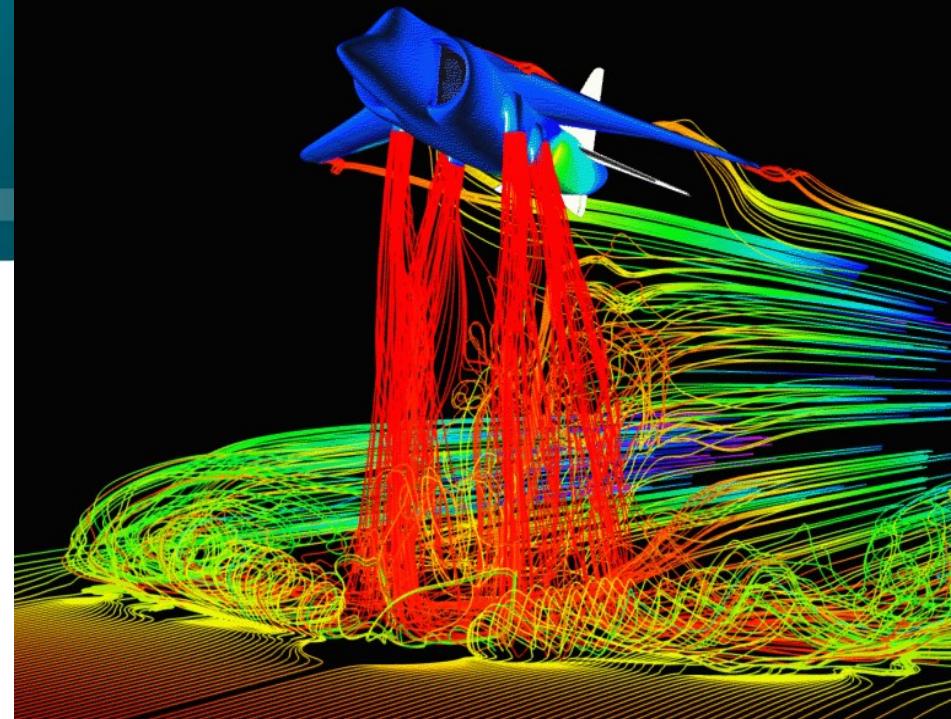
- Direct vs. indirect techniques
- Particle tracing
- Integral curves and surfaces
- Dense flow visualization techniques

Applications

- CFD flow visualization
- Weather visualization

If time permits

- Basic tensor visualization
- Visualization systems



Lecture Structure and Grading



Lectures

Weekly reading assignments (required + sometimes additional optional ones)

- Part of quiz questions (see later)

Programming assignments

- 6+1 programming assignments; short written report + personal presentation for each

Quizzes

- 4 (or maybe only 3, we'll see) quizzes, 30 min each;
announced a week in advance, roughly every 3-4 weeks
- From lectures, (required) reading assignments, programming assignments

Grading: 60% prog. assignments; 40% quizzes

No mid-term/final exam!



Resources

Course webpage:

https://vccvisualization.org/CS247_Scientific_Visualization/

Textbooks:

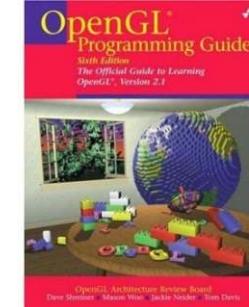
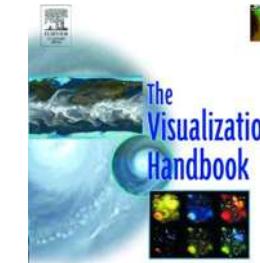
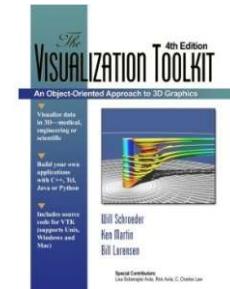
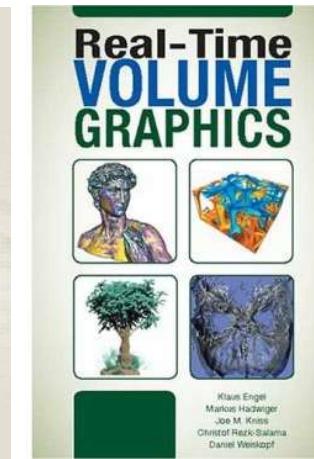
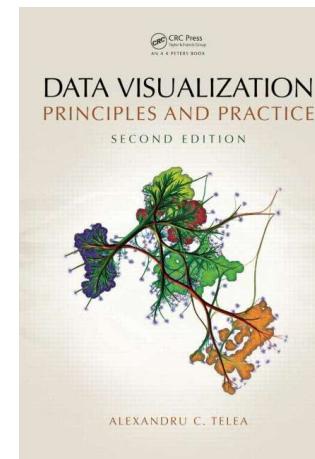
- Data Visualization: Principles and Practice
- Real-Time Volume Graphics

Additional books:

- The Visualization Toolkit:
An Object-Oriented Approach
to 3D Graphics (4th Edition)
- The Visualization Handbook
- OpenGL Programming Guide (9th edition, OpenGL 4.5)
www.opengl.org/documentation/red_book/

For GPU, GPGPU, and graphics programming, also look here:

https://vccvisualization.org/CS380_GPU_and_GPGPU_Programming/



Programming Assignments (1)



6 assignments (+1 introductory)

- Based on C/C++, JavaScript and OpenGL/WebGL
- You get a basic framework from us (in git repository)

Organization

1. Join discord channel: invite link [**look on blackboard or contact us**]
2. Use *git + github classroom* to get material and submit solution
Sign up: see discord channel!
Tutorial: https://www.youtube.com/watch?v=ObaFRGp_Eko
3. Assignment info and framework in git repository
4. Submit solution and report via git by submission deadline
5. Personal (online) presentation after submission

Programming Assignments (2)



- Submit via *git* at the latest on day the assignment is due (code, libs, everything that is needed to run your program)
- Submission must include short report (2 pages, pdf), including short explanation of algorithms, your solution, problems, how to run it, screenshots
- Personal presentations:
Present your program live and explain source code (10-15 min)
 - Sign up for presentation slot in advance (doodle)
 - Present to Alberto

Programming Assignments (3)



Grading

- Submission complete, code working for all the required features
- Documentation complete (report, but also source code comments!)
- Personal presentation
- Optional features, coding style, clean solution
- Every day of late submission reduces points by 10%
- No copies from the Internet (or anywhere else)!
You have to do it yourself and understand what you program:
your explanations during the presentations will be part of the grade!

Programming Assignments (4)



General contact: **kaust.cs247@gmail.com**

Teaching Assistants:

- Alberto Jaspe (alberto.jaspe@kaust.edu.sa)
 - main contact for assignments; assignment presentations
- Julio Rey Ramirez (julio.reyramirez@kaust.edu.sa)
 - help with programming questions



Help in programming assignments (in this order!):



- 1. Think about it, read about it, google it!**
- 2. Discuss on discord** (please register! if you do not know how, email Alberto)
3. Ask TAs: **kaust.cs247@gmail.com** (Alberto, Julio)

Programming Assignments Schedule (tentative)



| | | | |
|---------------|--|-------|---------------|
| Assignment 0: | Lab sign-up: join discord, setup github account + get repo Basic OpenGL example [we will offer a tutorial!] | until | Feb 1 |
| Assignment 1: | Volume slice viewer | until | Feb 15 |
| Assignment 2: | Iso-contours (marching squares) | until | Mar 1 |
| Assignment 3: | Iso-surface rendering (marching cubes) | until | Mar 15 |
| Assignment 4: | Volume ray-casting, part 1 | until | Apr 12 |
| | Volume ray-casting, part 2 | until | Apr 19 |
| Assignment 5: | Flow vis, part 1 (hedgehog plots, streamlines, pathlines) | until | May 3 |
| Assignment 6: | Flow vis, part 2 (LIC with color coding) | until | May 13 |

Reading Assignment #1 (until Feb 1)



Join discord; setup github classroom (Alberto gives you access)

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](http://tab.computer.org/vgtc/vrc/)**

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

Thank you.

Thanks for material

- Helwig Hauser
- Eduard Gröller
- Daniel Weiskopf
- Torsten Möller
- Ronny Peikert
- Philipp Muigg
- Christof Rezk-Salama