COSC 6344 Visualization

(Fall 2015)

Instructor: Guoning Chen

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Lecture time: Tue/Thur 10~11:30AM

Location: AH302

Office hours: Tue/Thur 11:30AM~12:30PM

Course web site: http://www2.cs.uh.edu/~chengu/Teaching/

Course summary and description:

Visualization has been established as a powerful means to help data owners from almost every discipline to make sense and present their diverse data, in order to verify or falsify hypotheses and discover new knowledge. The logic of visualization is to take advantages of our interpretation capability via visual perception channel and to encode information of the data into images and plots to improve our understanding of the data. Techniques from computer science, mathematics, cognitive and perception science, and physics are often adapted for various visualization problems. This introductory course covers topics from a number of sub-fields of visualization including information visualization and scientific visualization, and aims to show students how data visualization can help find solutions to a wide range of practical data interpretation problems occurring in many areas. Through this course, the students are expected to get familiar with a number of important techniques and methods for addressing the visualization of different basic types of data, and foster the ability to determine the proper visualization techniques when given a practical problem. This course serves as one of the core introductory level graduate courses, and helps build a complete course catalog in visual computing direction with the existing courses on imaging and computer graphics.

Topics:

- Visualization pipeline
    - Data acquisition, representation and pre-processing
- Elementary plots
- Visual perception and basic perception concepts
- Visual primitive: Colors (color theory) and Geometry
- Scalar field visualization
    - Color plots (2D) and volume rendering (3D)
    - Transfer function design

    - Iso-contouring and iso-surfacing
    - Scalar field topology
- Vector field visualization
    - Direct visualization
    - Geometric-based methods
    - Texture-based methods
    - Vector field topology
    - Time-dependent vector field visualization
- Tensor field visualization
    - Glyph-based methods
    - Geometric-based methods
    - Texture-based methods
    - Tensor field topology
- Information visualization
    - Graph visualization
    - Multi-dimensional data visualization
- Evaluation of the visualization techniques
- Visual analytics

Prerequisites: You are expected to know basics of linear algebra, linear systems, calculus, geometry, numerical analysis, and programming languages. Homework assignments and course projects will require knowledge of C/C++ and OpenGL library. Minimal familiarity with computer graphics principles and techniques is assumed. Having taken COSC-6372: Computer Graphics is encouraged but not required.

Textbooks (recommended, but not required)

Visualization techniques are highly application dependent and highly diversified! There is currently no a good book that can summarize all available techniques. However, the following textbooks provide a good introduction to some well-established techniques for a number of fundamental visualization problems.

- Data Visualization: Principles and Practice. Alexandru C. Telea, A.K. Peters, 2008.
- Introduction to Information Visualization. Riccardo Mazza, Springer, 2009.
- Charles D. Hansen and Chris R. Johnson, Visualization Handbook, Elsevier, 2004.

Reading Materials:

A collection of recent papers in visualization from the major conferences and journals.

Grading:

Project assignments – 50%

Mid-term exam – 15%

Final project – 25%

In-class participation (including discussion and presentation of papers) - (10%)

A student needs to score on average **at least 60% in total to pass the class**.

Late Policy

Late assignments will be marked off 10% for each weekday that it is late. **Each student can ask for the extension of one assignment up to 5 working days**.

Academic Dishonesty

Please do your own work. The default consequence for academic dishonesty is a failure for the course. It is okay to discuss with other students general ideas about implementing a program. It is NOT okay to copy another student's program. It is okay to discuss possible program bugs. It is NOT okay to debug another student's program.

Expectations

Students are expected to attend lectures, participate in the discussions, and complete project assignments on time. You should come to class prepared and speak up when something is not clear. Being prepared means completing the assigned reading and project assignments. Students are expected to be creative and have fun!

Students with Disabilities

Students with documented disabilities who may need accommodations, who have any emergency medical information the instructor should be aware of, or who need special arrangements in the event of evacuation, should make an appointment with the instructor as early as possible, and no later than the first week of the semester. Class materials will be made available in an accessible format upon request.

Tentative schedule

TIMELINE	MATERIAL COVERED
WEEK 1 (08/25, 27)	Class Preliminaries Introduction – History of visualization, Visualization pipeline, Data types and representations
WEEK 2 (09/01, 03)	Elementary plots (Assignment 1 out); OpenGL tutorial
WEEK 3 (09/08, 10)	Visualization systems, Color coding for scalar data visualization (Assignment 2 out);
WEEK 4 (09/15, 17)	Iso-contouring/ Iso-surfacing; Direct volume rendering – Ray casting (Assignment 3 out)
WEEK 5 (09/22, 24)	Direct volume rendering – Splatting, Transfer function design (Assignment 4 out)
WEEK 6 (09/29, 10/01)	Flow visualization introduction; Flow visualization techniques in 2D (arrow and color plots and streamlines)
WEEK 7 (10/06, 08)	Flow visualization techniques in 2D - texture-based; Topology-based vector field visualization I (Assignment 5 out)
WEEK 8 (10/13, 15)	Topology-based vector field visualization II; Final project topic review
WEEK 9 (10/20, 22)	Non-topological feature-based flow visualization; 3D flow visualization; Final project proposal due (Assignment 6 out)
WEEK 10 (10/27, 29)	**Mid-term exam** (**IEEE Visualization 2015)**
WEEK 11 (11/03, 05)	Streamline placement; Information theory framework; Unsteady flow visualization
WEEK 12 (11/10, 12)	Tensor data application – introduction and math; Geometric-based and texture-based tensor visualization; Glyph-based technique (Assignment 7 out)
WEEK 13 (11/17, 19)	Information visualization – graph and hierarchy data visualization
WEEK 14 (11/24)	Information visualization – high dimensional data visualization; **Thanksgiving**
WEEK 15 (12/01, 03)	Visual analytics; user study of visualization techniques

WEEK 16 (12/08, 10)	Final week; Final project presentations