COSC 6344 Visualization

(Fall 2019)

Instructor: Guoning Chen
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Lecture time: Tu/Th 1~2:30PM
Location: M 113
Office hours: Tu/Th 2:30pm-3:30pm or by appointment (**PLEASE schedule your appointment before stopping by my office**!)
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 various disciplines to MAKE SENSE and PRESENT their data, in order for decision making. Techniques from computer science, mathematics, cognitive and perception science, and human-computer interaction are often adapted for various visualization problems. This introductory course covers topics from a number of sub-fields of visualization and aims to show students how data visualization can help find solutions to a wide range of practical data interpretation problems arising in many areas. Through this course, students are expected to **(1) get familiar with important concepts and techniques/methods for the visualization of different basic types of data, and (2) foster the ability to select the proper visualization techniques when given a practical data visualization problem.** This course serves as one of the core introductory level graduate courses. Together with the existing courses on imaging and computer graphics, it helps build a complete course catalog in the direction of visual computing.

Topics:

- Visualization and visualization pipeline
- Visual perception and basic perception concepts
- Visual primitive: Colors (color theory) and Geometry
- Principles of effective graphical representation
- Scalar data visualization
    - Color plots (2D) and volume rendering (3D)
    - Transfer function design
    - Iso-contouring and iso-surfacing
    - Scalar field topology (advanced)
- Vector-valued data visualization
    - Direct visualization
    - Geometric-based methods
    - Texture-based methods
    - Vector field topology

    - Time-dependent and high-dimensional vector field visualization
- Tensor data visualization
    - Glyph-based methods
    - Geometric-based methods
    - Texture-based methods
- Information visualization
    - Graph visualization
    - Multi-dimensional data visualization
- Evaluation of the visualization techniques
- Visual analytics

Prerequisites: You are expected to have basics knowledge on linear algebra, linear systems, calculus, geometry, numerical analysis, and programming languages. Homework assignments and course projects will **require knowledge and experience of C/C++ and OpenGL library**. You need to have solid grasp of **data structure and algorithm design**. Minimal familiarity with computer graphics principles and techniques is assumed. Having taken COSC 6372: Computer Graphics is ideal 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. Second Edition. Alexandru C. Telea, A.K. Peters, 2014.
- Introduction to Information Visualization. Riccardo Mazza, Springer, 2009.
- Charles D. Hansen and Chris R. Johnson, Visualization Handbook, Elsevier, 2004.
- Storytelling with Data. Cole Nussbaumer Knaflic, Wiley, 2015.

Reading Materials:

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

Grading:

- Assignments – 45%
- Mid-term exam and a final open-note quiz – 25%
- Final project – 25%
- In-class participation (including discussion and presentation of papers and projects) - (5%)
- A student needs to score on average **at least 60% in total to pass the class**.

- *Grading scale (tentative): A: >92%; A-: >88%; B+: >84%; B: >80%; B-: >74%; C+: >68%; C: > 60%;*

Late Policy:

Late assignments will be marked off **20%** 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.

Counseling and Psychological Services (CAPS) can help students who are having difficulties managing stress, adjusting to the demands of a professional program, or feeling sad and hopeless. You can reach CAPS (www.uh.edu/caps) by calling **713-743-5454** during and after business hours for routine appointments or if you or someone you know is in crisis. No appointment is necessary for the “Let's Talk” program, a drop-in consultation service at convenient locations and hours around campus. http://www.uh.edu/caps/outreach/lets_talk.html

Tentative schedule:

TIMELINE	MATERIAL COVERED
WEEK 1 (08/20, 22)	Class Preliminaries Introduction – History of visualization, Visualization pipeline; Data type and data representation
WEEK 2 (08/27, 08/29)	Visual perceptions; Principles of effective plots (Assignment 1 out);
WEEK 3 (09/03, 05)	Colors in visualization; OpenGL Tutorial (Assignment 2 out);
WEEK 4 (09/10, 12)	Color coding for scalar data visualization; Iso-contouring/ Iso-surfacing; Direct (Assignment 3 out)
WEEK 5 (09/17, 19)	Direct Volume rendering – Ray casting and Splatting
WEEK 6 (09/24, 26)	Transfer function design (Assignment 4 out); Vector field/flow visualization introduction;
WEEK 7 (10/01, 03)	Flow visualization techniques in 2D -arrow and color plots, streamlines, texture-based (Assignment 5 out)
WEEK 8 (10/08, 10)	Vector field feature-based visualization
WEEK 9 (10/15, 17)	3D vector field visualization; unsteady flow visualization (Assignment 6 out)
WEEK 10 (10/22, 24)	Mid-term review; Mid-term exam (**IEEE Visualization 2019**)
WEEK 11 (10/29, 10/31)	Tensor data application – introduction and math; Geometric-based and texture-based tensor visualization;
WEEK 12 (11/05, 07)	Glyph-based technique (Assignment 7 out); Information visualization – graph and hierarchy data visualization
WEEK 13 (11/12, 14)	Information visualization – high dimensional data visualization;
WEEK 14 (11/19, 11/21)	Final project presentations
WEEK 15 (11/26, 11/27)	Multifield visualization, **Thanksgiving**