

COSC 6344 Visualization

(Fall 2020)

Instructor: Guoning Chen

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Lecture time: Tu/Th 1~2:30PM

Office hours: Tu/Th 2:30pm-3:30pm taking place on MS Teams (Check your Teams Calendar for the link)

Course web site:

http://www2.cs.uh.edu/~chengu/Teaching/Fall2020/COSC6344_Visualization_Fall2020.html

Piazza link: <http://piazza.com/uh/fall2020/cosc6344fa202015914>

Course Delivery Format and Exam:

This course is being offered in the Synchronous Online format. Synchronous online class meetings will take place according to the class schedule. There is no face-to-face component to this course. In between synchronous class meetings, there may also be asynchronous activities to complete (e.g., discussion forums and assignments). This course will have a mid-term exam. The exam will be delivered in the synchronous online format, and the specified date and time will be announced during the course. Prior to the exam, descriptive information, such as the number and types of exam questions, resources and collaborations that are allowed and disallowed in the process of completing the exam, and procedures to follow if connectivity or other resource obstacles are encountered during the exam period, may be provided.

Course summary and description:

Visualization has been established as a powerful means to help domain experts from various disciplines or general audience to MAKE SENSE and PRESENT their data, for decision making. Techniques and knowledge from different sub-fields of computer science (including computer graphics, image processing, data structures and algorithms, high performance computing, machine learning, and human-computer interaction), mathematics, cognitive and perception science, and specific application domains 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, principles, and techniques/methods for the visualization of different 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, and it helps build a complete course catalog in the direction of visual computing with courses like image processing, computer graphics, and computer vision.

Topics:

- Definition of visualization and visualization pipeline
- Visual perception and basic perception concepts
- Visual primitive: Colors (color theory) and Geometry
- Principles of effective graphical representation (charts and plots)

- Scalar data visualization
 - Direct methods: color plots (2D) and volume rendering (3D)
 - Geometric-based methods: Iso-contouring (2D) and iso-surfacing (3D)
 - Feature-based method: scalar field topology
- Vector-valued data visualization
 - Direct methods: color plots, arrow plots, icons
 - Geometric-based methods: integral curves (2D/3D), integral surfaces (3D)
 - Texture-based methods: LIC (2D), IBFV (2D), and their variants
 - Feature-based methods: vortices, flow separation, vector field topology
 - Time-dependent and high-dimensional vector field visualization
- Tensor data visualization
 - Direct methods: color plots, line plots, glyph-based methods
 - Geometric-based methods: hyperstreamlines, tensorlines
 - Texture-based methods: extended LIC and IBFV
 - Feature-based methods: feature lines, tensor field topology
- Information visualization
 - Graph and tree 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++ and/or Python**. Visualization Toolkit (VTK) will be used with either C++ or Python to complete the programming assignments. 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 textbook 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 published in major conferences and journals of Visualization, such as IEEE VIS, IEEE TVCG, CGF, EuroVis, and PacificVis.

Grading:

- Assignments – 30%
- Mid-term exam – 20%
- In-class quizzes – 15%
- Final project – 30%
- 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%;

Tentative schedule:

TIMELINE	MATERIAL COVERED
WEEK 1 (08/25, 27)	Introduction – History of visualization, Visualization pipeline; Data type and data representation
WEEK 2 (09/01, 03)	Visual perceptions; Principles of effective plots (Assignment 1 out);
WEEK 3 (09/08, 10)	Colors in visualization; VTK introduction
WEEK 4 (09/15, 17)	Final project introduction; Color plots and iso-contouring for 2D scalar field visualization (Assignment 2 out)
WEEK 5 (09/22, 24)	Iso-surfacing and Direct Volume rendering (DVR) – Ray casting for 3D scalar field visualization (Assignment 3 out)
WEEK 6 (10/06, 08)	DVR- Splatting and texture-based; Transfer function design;
WEEK 7 (10/13, 15)	Vector field introduction and visualization techniques in 2D -arrow and color plots, streamlines, texture-based (Assignment 4 out)
WEEK 8 (10/20, 22)	Vector field feature-based visualization; 3D vector field visualization
WEEK 9 (10/27, 29)	Mid-term exam ; IEEE Visualization 2020

WEEK 10 (11/03, 05)	Unsteady flow visualization; Tensor field visualization – overview; (Assignment 5 out)
WEEK 11 (11/10, 12)	Tensor field visualization – Geometric-based and texture-based methods; Glyph-based technique
WEEK 12 (11/17, 19)	Information visualization – graph and hierarchy data visualization
WEEK 13 (11/24, 26)	Information visualization – high dimensional data visualization; Thanksgiving holiday (no class)
WEEK 14 (12/01, 03)	Final project presentations

Excused Absence Policy:

Regular class attendance, participation, and engagement in coursework are important contributors to student success. Absences may be excused as provided in the University of Houston [Undergraduate Excused Absence Policy](#) and [Graduate Excused Absence Policy](#) for reasons including: medical illness of student or close relative, death of a close family member, legal or government proceeding that a student is obligated to attend, recognized professional and educational activities where the student is presenting, and University-sponsored activity or athletic competition. Additional policies address absences related to [military service](#), [religious holy days](#), [pregnancy and related conditions](#), and [disability](#).

Recording of Class:

Students may not record all or part of class, livestream all or part of class, or make/distribute screen captures, without advanced written consent of the instructor. If you have or think you may have a disability such that you need to record class-related activities, please contact the [Center for Students with DisABILITIES](#). If you have an accommodation to record class-related activities, those recordings may not be shared with any other student, whether in this course or not, or with any other person or on any other platform. Classes may be recorded by the instructor. Students may use instructor’s recordings for their own studying and notetaking. Instructor’s recordings are not authorized to be shared with *anyone* without the prior written approval of the instructor. Failure to comply with requirements regarding recordings will result in a disciplinary referral to the Dean of Students Office and may result in disciplinary action.

Late Submission Policy:

Late assignments will be marked off **20%** for each weekday that it is late. Submissions made 5 days after deadline will not be accepted unless due to causes out of control of the students.

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.

Honor Code Statement:

Students may be asked to sign an honor code statement as part of their submission of any graded work including but not limited to projects, quizzes, and exams: *"I understand and agree to abide by the provisions in the [University of Houston Graduate Academic Honesty Policy](#). I understand that academic honesty is taken very seriously and, in the cases of violations, penalties may include suspension or expulsion from the University of Houston."*

Syllabus Changes:

Due to the changing nature of the COVID-19 pandemic, please note that the instructor may need to make modifications to the course syllabus and may do so at any time. Notice of such changes will be announced as quickly as possible through UH email, course webpage, and course Piazza.

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.

Resources for Online Learning

The University of Houston is committed to student success, and provides information to optimize the online learning experience through our [Power-On](#) website. Please visit this website for a comprehensive set of resources, tools, and tips including: obtaining access to the internet, AccessUH, and Blackboard; requesting a laptop through the Laptop Loaner Program; using your smartphone as a webcam; and downloading Microsoft Office 365 at no cost. For questions or assistance contact UHOnline@uh.edu.

UH Email

Email communications related to this course will be sent to your [Exchange email account](#) which each University of Houston student receives. The Exchange mail server can be accessed via Outlook, which provides a single location for organizing and managing day-to-day information, from email and calendars to contacts and task lists. Exchange email accounts can be accessed by logging into Office 365 with your CougarNet credentials or through Access UH. They can also be configured on [IOS](#) and [Android](#) mobile devices. Additional assistance can be found at the [Get Help](#) page.

Webcams

Webcams must be turned on during lectures and the mid-term exam to allow the monitoring of attendance and to ensure the academic integrity of exam administration.

Please read the following carefully if you need any help

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

Helpful Information

- **COVID-19 Updates:** <https://uh.edu/covid-19/>
- **Coogs Care:** <https://www.uh.edu/dsaes/coogscare/>
- **Laptop Checkout Requests:** <https://www.uh.edu/infotech/about/planning/off-campus/index.php#do-you-need-a-laptop>
- **Health FAQs:** <https://uh.edu/covid-19/faq/health-wellness-prevention-faqs/>
- **Student Health Center:** <https://uh.edu/class/english/lcc/current-students/student-health-center/index.php>