UNIVERSITY of HOUSTON

NATURAL SCIENCES AND MATHEMATICS

COURSE TITLE/SECTION: COSC6344 Visualization (13073, Fall 2023, Face-to-Face)

TIME: Tu/Th 1~2:30PM
LOCATION: CBB 118
FACULTY: Guoning Chen
OFFICE HOURS: Thursday 2:30pm-4:00pm PGH 566
EMAIL: gchen22@central.uh.edu
OFFICE PHONE: 713-743-5788
COURSE WEB SITE:
http://www2.cs.uh.edu/%7Echengu/Teaching/Fall2023/COSC6344_Visualization_Fall2023.html

TA: Nguyen K Phan

Course: COSC6344 Visualization

A. Catalog Description: Introduction to the concepts, pipeline, principles, and techniques of visualization for various data forms, including graphs, trees, tables, higher-dimensional data, scalar, and vector-valued data, stemming from various real-world applications.

B. Prerequisites: COSC 4370 or COSC 6372 or consent of instructor
You are expected to have basic knowledge of linear algebra, linear systems, calculus, geometry, numerical analysis, and programming languages. Homework assignments and course projects will require knowledge and experience of Python. Visualization Toolkit (VTK) will be used with Python to complete the programming assignments. You need to have a 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.

Course Objectives:

This introductory course covers topics from a few 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.

Course Content:

This course will cover the following 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: hyper-streamlines, tensor lines
    - 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

Course Structure:

The following provides a tentative schedule of the course that is subject to change due to delays or other unexpected incidents.

TIMELINE	TOPICS
WEEK 1 (08/22, 24)	Class introduction, Visualization pipeline; Data type and data representation
WEEK 2 (08/29, 09/01)	Visual perceptions; Colors in visualization
WEEK 3 (09/05, 07)	VTK introduction; 2D scalar field visualization - color plots and iso-contouring (Assignment 1 out)

WEEK 4 (09/12, 14)	3D vector field visualization - Iso-surfacing; Direct volume rendering (DVR) – Ray casting (Assignment 2 out)
WEEK 5 (09/19, 21)	DVR- Splatting and texture-based; Transfer function design;
WEEK 6 (09/26, 28)	**Exam 1**; 2D vector field visualization – streamlines (Assignment 3 out)
WEEK 7 (10/03, 05)	2D vector field visualization - texture-based; Final project introduction
WEEK 8 (10/10, 12)	feature-based visualization for vector fields;
WEEK 9 (10/17, 19)	3D vector field visualization (Assignment 4 out); Unsteady flow visualization;
WEEK 10 (10/24, 26)	Tensor field visualization – overview; Tensor field visualization – Geometric-based and texture-based methods;
WEEK 11 (10/31, 11/02)	Tensor field visualization - Glyph-based technique; Information visualization – elementary plotting (Assignment 5 out);
WEEK 12 (11/07, 09)	Information visualization – graph and hierarchy data visualization
WEEK 13 (11/14, 16)	Review; **Exam 2**;
WEEK 14 (11/21, 23)	Information visualization – high dimensional data visualization; **Thanksgiving holiday (no class)**
WEEK 15 (11/28, 11/30)	Final project presentations

Textbooks:

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 few 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.

Please attend the lectures of the class as the details of most topics will only be described and explained by me during the lectures. No recordings will be provided!

Evaluation and Grading:

- Assignments – 20%
- Exams – 40%
- In-class quizzes – 15%
- Final project – 25%

Written and Programing Assignments. There will be a few programming assignments that will be completed using Python with the VTK library. These assignments can also be completed using C++ with the VTK library. Each assignment will require the students to write a report about their implementation and the findings from the given data sets.

Exams: There will be two **in-person** exams covering the topics before the respective exam dates. These exams will have both theoretical and practical questions and are open-book and open-note. More details will be given in the class. Both exams will be administered with CASA Monitor. Please follow this link to activate your CASA monitor. It is strongly recommended that you test it using this link BEFORE the exam to ensure that it works smoothly.

Quizzes: In-class quizzes will be given weekly or bi-weekly to test how well students understand the course materials of the week. Quizzes will take place on paper or on Canvas randomly. The lowest three quiz scores will be dropped.

Final project: There will be a final project for this course that requires the students to implement a recent visualization technique or implement a simple visualization for data exploration. Options and requirements for the final projects will be given on the course webpage.

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%;*

Policy on grades of I (Incomplete): The grade of "I" (Incomplete) is a conditional and temporary grade given when a student, for reasons beyond his or her control, has not completed a relatively small portion of all requirements. Sufficiently serious,

documented situations include illness, death in the family, etc. The student who applies for a grade of "I" will need to complete the remaining components of the course before the deadline agreed by both the student and the instructor (usually within one year after the completion of the course). Failing to do so will result in a grade of "F" (Fail) for the course.

Class Rules:

- Our time together is very valuable; please treat it accordingly. By enrolling in this course, you make a personal contract with me and your classmates to attend and diligently participate in every class activity. Students are expected to be courteous toward the instructor and their classmates throughout the duration of this course. Please do not interrupt the class (e.g., chat) without the permission from the instructor or lab supervisor.
- **Late Submission Policy:** Late assignments will be marked off 20% for each weekday that it is late. Submissions made 5 days after the deadline will not be accepted unless due to causes out of control of the students.
- **Makeup policy:** There are NO make-up quizzes since the lowest three quiz scores will be dropped. There are no make-up assignments or exams unless an acceptable excuse is provided BEFORE the due date of the assignments or the time of the exam. Please refer to the excused absence policy below for more details.
- All exams and quizzes will take place in person during classes. No remote exams and quizzes will be administered.
- TAs should be contacted first for questions regarding materials, exercises, exams, or projects. The instructor may be contacted for other issues (i.e., administrative), or if TAs were unable to answer a question.

Addendum: Whenever possible, and in accordance with 504/ADA guidelines, the University of Houston will attempt to provide reasonable academic accommodations to students who are registered and approved through the Center for Students with Disabilities. Students are responsible for communicating with the faculty to be sure appropriate arrangements are made. Registering with CSD is not sufficient. Communication is critical. Please call 713-743-5400 for more assistance.

Mental Health and Wellness Resources

The University of Houston has a number of resources to support students' mental health and overall wellness, including CoogsCARE and the UH Go App. UH Counseling and Psychological Services (CAPS) offers 24/7 mental health support for all students, addressing various concerns like stress, college adjustment and sadness. CAPS provides individual and couples counseling, group therapy, workshops and connections to other support services on and off-campus. For assistance visit uh.edu/caps, call 713-743-5454, or visit a Let's Talk location in-person or

virtually. Let's Talk are daily, informal confidential consultations with CAPS therapists where no appointment or paperwork is needed.

The Student Health Center offers a Psychiatry Clinic for enrolled UH students. Call 713-743-5149 during clinic hours, Monday through Friday 8 a.m. - 4:30 p.m. to schedule an appointment.

The A.D. Bruce Religion Center offers spiritual support and a variety of programs centered on well-being.

Need Support Now?
If you or someone you know is struggling or in crisis, help is available. Call CAPS crisis support 24/7 at 713-743-5454, or the National Suicide and Crisis Lifeline: call or text 988, or chat 988lifeline.org.

Academic Honesty Policy

High ethical standards are critical to the integrity of any institution, and bear directly on the ultimate value of conferred degrees. All UH community members are expected to contribute to an atmosphere of the highest possible ethical standards. Maintaining such an atmosphere requires that any instances of academic dishonesty be recognized and addressed.
The UH Academic Honesty Policy is designed to handle those instances with fairness to all parties involved: the students, the instructors, and the University itself. All students and faculty of the University of Houston are responsible for being familiar with this policy.

Title IX/Sexual Misconduct

Per the UHS Sexual Misconduct Policy, your instructor is a "responsible employee" for reporting purposes under Title IX regulations and state law and must report incidents of sexual misconduct (sexual harassment, non-consensual sexual contact, sexual assault, sexual exploitation, sexual intimidation, intimate partner violence, or stalking) about which they become aware to the Title IX office. Please know there are places on campus where you can make a report in confidence. You can find more information about resources on the Title IX website at https://uh.edu/equal-opportunity/title-ix-sexual-misconduct/resources/.

Reasonable Academic Adjustments/Auxiliary Aids

The University of Houston is committed to providing an academic environment and educational programs that are accessible for its students. Any student with a disability who is experiencing barriers to learning, assessment or participation is encouraged to contact the Justin Dart, Jr. Student Accessibility Center (Dart Center) to learn more about academic accommodations and support that may be available to them. Students seeking academic accommodations will need to register with the Dart Center as soon as possible to ensure timely implementation of approved accommodations. Please contact the Dart Center by visiting the website: https://uh.edu/accessibility/ calling (713) 743-5400, or emailing jdcenter@Central.UH.EDU.

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. Under these policies, students with excused absences will be provided with an opportunity to make up any quiz, exam or other work that contributes to the course grade or a satisfactory alternative. Please read the full policy for details regarding reasons for excused absences, the approval process, and extended absences. 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 Justin Dart, Jr. Student Accessibility Center. 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.

NOTE: The materials provided by the instructor in this course are for the use of the students enrolled in the course only. Copyrighted course materials may not be further disseminated without instructor permission. This includes sharing content to commercial course material suppliers such as Course Hero or Chegg. Students are also prohibited from sharing materials derived from the instructor's content (e.g., a student's lecture notes).

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, Blackboard, and Canvas; using your smartphone as a webcam; and downloading Microsoft Office 365 at no cost. For questions or assistance contact UHOnline@uh.edu.

UH Email

Please check and use your Cougarnet email for communications related to this course. Faculty use the Cougarnet (or equivalent central) email to respond to course-related inquiries such as grade queries or progress reports for reasons of FERPA. To access your Cougarnet email, login to your Microsoft 365 account with your Cougarnet credentials. Visit University

Information Technology (UIT) for instructions on how to connect your Cougarnet e-mail on a mobile device.

Webcams

Webcams must be turned on during exams to ensure the academic integrity of exam administration.

Security Escorts and Cougar Ride

UHPD continually works with the University community to make the campus a safe place to learn, work, and live. The security escort service is designed for the community members who have safety concerns and would like to have a Security Officer walk with them, for their safety, as they make their way across campus. Based on availability either a UHPD Security Officer or Police Officer will escort students, faculty, and staff to locations beginning and ending on campus. If you feel that you need a Security Officer to walk with you for your safety, please call 713-743-3333. Arrangements may be made for special needs.

Parking and Transportation Services also offers a late-night, on-demand shuttle service called "Cougar Ride" that provides rides to and from all on-campus shuttle stops, as well as the MD Anderson Library, Cougar Village/Moody Towers and the UH Technology Bridge. Rides can be requested through the UH Go app. Days and hours of operation can be found at https://uh.edu/af-university-services/parking/cougar-ride/.

Syllabus Changes

Please note that the instructor may need to make modifications to the course syllabus. Notice of such changes will be announced as quickly as possible through Canvas, emails, and Teams.

Artificial Intelligence

Generative AI technologies, like ChatGPT, can be used to generate any source code for the homework and assignments, but it needs to be reported. They should NOT be used to produce the answers for the written questions of the assignments. **They CANNOT be used during exams** and **quizzes**. Violation of this policy will result in zero for the corresponding assignment, exam, or quiz.