UNIVERSITY of **HOUSTON**

NATURAL SCIENCES AND MATHEMATICS

COURSE TITLE/SECTION: **COSC6344 Visualization** (14573, Fall 2021, Face-to-Face)

TIME: Tu/Th 1~2:30PM
LOCATION: Science Building S 114
FACULTY: Guoning Chen
OFFICE HOURS: Tu/Th 2:30pm-3:30pm taking place **virtually via MS Teams** (Please check your Teams Calendar for the link)
EMAIL: gchen22@central.uh.edu or gchen16@uh.edu
OFFICE PHONE: 713-743-5788
COURSE WEB SITE:
http://www2.cs.uh.edu/~chengu/Teaching/Fall2021/COSC6344_Visualization_Fall2021.html

MS TEAMS LINK: TBD
TA: TBD

I.   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 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.

II.   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.

III. **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: 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

IV. **Course Structure:** The following provides a tentative schedule of the course that is subject to change due to delay or other unexpected incidents.

TIMELINE	MATERIAL COVERED
WEEK 1 (08/24, 26)	Introduction – History of visualization, Visualization pipeline; Data type and data representation
WEEK 2 (08/31, 9/03)	Visual perceptions; Principles of effective plots (Assignment 1 out);
WEEK 3 (09/07, 09)	Colors in visualization; VTK introduction

WEEK 4 (09/14, 16)	Final project introduction; Color plots and iso-contouring for 2D scalar field visualization (Assignment 2 out)
WEEK 5 (09/21, 23)	Iso-surfacing and Direct Volume rendering (DVR) – Ray casting for 3D scalar field visualization (Assignment 3 out)
WEEK 6 (09/28, 30)	DVR- Splatting and texture-based; Transfer function design;
WEEK 7 (10/05, 07)	Vector field introduction and visualization techniques in 2D -arrow and color plots, streamlines, texture-based (Assignment 4 out)
WEEK 8 (10/12, 14)	Vector field feature-based visualization; 3D vector field visualization
WEEK 9 (10/19, 21)	Unsteady flow visualization; Review
WEEK 10 (10/26, 28)	**Mid-term exam**; IEEE Visualization 2021
WEEK 11 (11/02, 04)	Tensor field visualization – overview; (Assignment 5 out)
WEEK 12 (11/09, 11)	Tensor field visualization – Geometric-based and texture-based methods; Glyph-based technique
WEEK 13 (11/16, 18)	Information visualization – graph and hierarchy data visualization
WEEK 14 (11/23, 25)	Information visualization – high dimensional data visualization; **Thanksgiving holiday (no class)**
WEEK 15 (11/30, 12/02)	Final project presentations

V.   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.

VI.   Course Requirements:

A.   **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 finding from the given data sets.

__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 accepted unless due to causes out of control of the students.

B.   **Mid-Term Exam:** There will be one mid-term exam covering the topics before the exam date. This mid-term exam will have both theoretical and practical questions, and it is a closed-book and closed-note exam. More details will be given in the class.

C.   **Quizzes:** In-class quizzes will be given each week to test how well students understand the course materials of the week. Quizzes will take place on Blackboard and consists of multiple choices and true/false questions.

D.   **Final project (This is required for some core courses)** 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.

VII.   Evaluation and Grading:

- Assignments – 30%
- Mid-term exam – 20%
- In-class quizzes – 15%
- Final project – 30%
- In-class participation (including discussion and presentation of 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%;*

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). Fail to do so will result in a grade of "F" (Fail) for the

course.

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.

Academic Honesty: It is each student's responsibility to read and understand the Academic Honesty Policy found at http://catalog.uh.edu/content.php?catoid=6&navoid=1025. There will be no tolerance towards academic dishonesty, and cheating can lead to report of a violation of the Academic Honesty policy to the UH Office of Undergraduate Academic Affairs. Specifically for this course, 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
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.*"

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).

Face Covering Policy:
To reduce the spread of COVID-19, the University strongly encourages everyone (vaccinated or not) to wear face coverings indoors on campus including classrooms for both faculty and students.

Presence in Class:
Your presence in class each session means that you:

- Are NOT exhibiting any Coronavirus Symptoms that makes you think that you may have COVID-19
- Have NOT tested positive or been diagnosed for COVID-19
- Have NOT knowingly been exposed to someone with COVID-19 or suspected/presumed COVID-19

If you are experiencing any COVID-19 symptoms that are not clearly related to a pre-existing medical condition, do not come to class. Please see Student Protocols for what to do if you experience symptoms and Potential Exposure to Coronavirus for what to do if you have potentially been exposed to COVID-19. Consult the (select: Undergraduate Excused Absence Policy or Graduate Excused Absence Policy) for information regarding excused absences due to medical reasons.

COVID-19 Information:
Students are encouraged to visit the University's COVID-19 website for important information including on-campus testing, vaccines, diagnosis and symptom protocols, campus cleaning and safety practices, report forms, and positive cases on campus. Please check the website throughout the semester for updates.

Vaccinations:
Data suggests that vaccination remains the best intervention for reliable protection against COVID-19. Students are asked to familiarize themselves with pertinent vaccine information, consult with their health care provider. The University strongly encourages all students, faculty, and staff to be vaccinated.

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 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.

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 Acccess 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 virtual learning sessions 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

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 team on MS Teams.