INF 385T – Visualization
Spring 20201

Unique ID: 28440 / 28445
Room: ACB 1.114
Time: Thursdays 15:00-18:00

Professor: Luis Francisco-Revilla
Office: ACB 3.248
Phone: 512-232-6933

E-mail: revilla@tacc.utexas.edu
Office hours: by appointment

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1 Overview

Visualization is crucial for understanding data. The value of data is its potential to become information, and knowledge, and visualization plays a crucial role in this process. In today's world, we are collecting vast amount of data from myriad sources. We increasingly measure more variables about in every field of inquire from economic, scientific and biological systems, to human behavior phenomena, to health, and to humanities. We collect and analyze data about local, national and global economy, weather and climate effects, traffic in our roads, infection rates and effectiveness of clinical treatments, and even LIDAR scans of archeological sites. This is allowing us to increasingly move towards establishing better a data-driven decision making processes and policies. However, in order to effectively capitalize on the benefits of this data, it is crucial that the users can understand it. Users need to be able to identify patterns and trends, identify interesting variations that allow us to differentiate signal from the noise, understand the phenomena, and infer the underlying processes, and potentially predict future phenomena. This course focuses on understanding the principles and practices for visualizing different large datasets, numeric and textual, structured and unstructured, using different approaches, ranging from 2-dmiensional information visualizations, to 3-dimensional scientific visualizations, to visualizations using new platforms such as eXtended Reality (XR). We will explore new ways to use color to facilitate the discovery of interesting phenomena, and we will study alternative Web-based toolkits, desktop products, and headset displays.

2 Objectives

Through this course, students will develop:

- theoretical knowledge of the research areas of Visualization, including information visualization, scientific visualization, and eXtended Reality (XR)
- practical skills for designing, building, and evaluating interactive visualization applications for Visualization Environments that use multiple systems, including: 2D visualizations, 3D visualizations, XR, etc.

3 Course Structure and Organization

This course has three parallel narratives:

- Independent readings
- In-class discussions and presentations
- Mid-semester Project: interactive information visualization (2D)
- Final Project: interactive XR visualization (3D)

All students are expected to complete the weekly reading assignments before class time. Reading assignments include book chapters, research papers, and online tutorials.

ALL students are expected to read and understand ALL assignments, and participate actively in the class discussions

4 Group Work

This course includes both individual work, and collaborative work in groups. Students will form groups of 3-4 members, and complete two projects, producing an interactive visualization application for each of them. The first project will be an information visualization project, in which the students will create a 2D visualization of a dataset. The second project and final project requires students to create a 3D model that the users will be able to explore using XR devices (for example a heads up display for virtual reality, or an augmented reality application running on a phone. For each project, the instructor will provide each group with a dataset. The design and implementation of both projects will allow users to explore and understand the multiple dimensions of the data.

The final project requires considerable time to prepare

This course structure aims to create a learning environment where questions, concepts and skills are discussed, analyzed, and developed collaboratively. This format depends on the participation of all class members. Therefore, all students are expected to:

- Attend all class sessions; if a student misses a class, it is his or her responsibility to obtain all notes, handouts, and assignment sheets.
- Read all material prior to class; students are expected to complete the readings, and participate actively in all class discussions and group activities.
- Submit all assignments fully and on time. Late submissions will not be accepted (in the event of an emergency, students must contact the instructor).
- Educate themselves and their peers. The successful completion of this course and their participation in the information professions depend upon the students' willingness to demonstrate initiative and creativity.

5 Academic Integrity

University of Texas Honor Code

The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the university is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community.

Academic dishonesty, such as plagiarism, cheating, or academic fraud, will not be tolerated and will incur severe penalties, including failure for the course. If there is concern about behavior that may be academically dishonest, consult the instructor. Further information about plagiarism and its consequences can be found at:

http://deanofstudents.utexas.edu/conduct/standardsofconduct.php

6 Documented Disability Statement

Any student with a documented disability who requires academic accommodations should contact Services for Students with Disabilities at 471-6259 (voice) or 1-866-329-3986 (Video Phone) as soon as possible to request an official letter outlining authorized accommodations.

Please notify me as quickly as possible if the material being presented in class is not accessible (for example, instructional videos need captioning, course packets are not readable for proper alternative text conversion, etc.).

7 Amendments to Syllabus

The instructor reserves the right to make amendments to the syllabus as the semester progresses in order to improve it, and to respond to unexpected events.

8 Reading Assignments

There are two types of reading assignments: papers and books. Most papers are available online. The books include:

- Charlie Fink. “Metaverse - An AR Enabled Guide to AR & VR”. January 1, 2018

The list of all paper assignments is provided at the end of this document

9 Important Dates

Week		Topic	Invited Talks	Assignments Books
1	Jan-21	Introduction		
2	Jan-28	General		
3	Feb-04	Best Papers		
4	Feb-11	Conceptual Visualization	Jo Wozniak	
5	Feb-18	Color, Gestalt	Stephanie Zeller	Interaction of Color: 50th Anniversary Ed.
6	Feb-25	D3 Tutorial		D3 Tutorial
7	Mar-4	Data Formats, Wrangling		
8	**Mar-11**	**Info Vis Project**		
9	Mar-18	SPRING BREAK		
10	Mar-25	Visualization and Accessibility		
11	Apr-01	Scientific Visualization	Anne Bowen	
12	Apr-08	Metaverse Chapters 1-9		Metaverse Part 1
13	Apr-15	Babylon Tutorial		
14	Apr-22	Authoring XR Content		
15	Apr-29	Metaverse Chapters 10-Conclusion		Metaverse Part 2
16	**May-06**	**Final Project Day**		

10 Grading

The Letter Grade for the course is determined based on **minimum grade requirements** AND the **final numeric score**.

Minimum letter grade requirements

Letter Grade	Numeric Score	Minimum Requirements
A	96 - 100%	
A-	90 - 95%	• Both Projects must be functional and meet all the specifications.
B+	87 - 89%	
B	84 - 86%	
B-	80 - 83%	• Both Projects must function at least partially, meeting the most important specifications, and provide a proof of concept.
C+	77 - 79%	
C	74 - 76%	
C-	70 - 73%	
D+	66 - 69%	
D	60 - 65%	

(higher grades must meet all the minimum requirements of lower grades)

Final Numeric Score

The final numeric score for the course is computed based on the following:

5%	Class Participation	(individual)
30%	Reading Assignments	(individual)
20%	Presentations	(individual)
20%	First Project	(group)
25%	Final Project	(group)
100%	**Final Numeric Score**	

10.1 Class Participation (Individual)

All students are expected to participate in class activities and discussions.

10.2 Reading Assignments (Individual)

The goal of the reading assignments is that every student develops an overarching view of the research areas that contribute to the field of Data and Information Visualization.

Every student is expected to read all the reading assignments, understand them, and participate actively in the class discussions.

Additionally, every student must prepare 3 reading points for every reading assignment. Reading points should identify the strengths and most important lessons learned from the reading.

The class instructor can ask for this points during the class.
Failure to prepare this reading points will result in failing the reading assignment for that week.

10.3 Presentations (Individual)

Each student will be assigned to present at least **2 research papers** (this will be modified depending on how many students register for the class). Students are expected to present the papers by conducting 3 roles:

1. Hunter-Gatherer – explain the paper's background and discuss the context: *who, where, when, what* of authors, project, and research area
2. Reviewer – explain the paper. Specifically, the presenter must:
   a. Present a **brief synopsis**
   b. Discuss the strengths and weaknesses of work
   c. Identify the major contributions and the take home lessons
3. Lead discussant – guide the in-class discussion based on the *discussion points* that all the other class members submitted.

It is expected to have a visual presentation support for the *hunter-gatherer* and *reviewer* components of the presentation

10.4 Projects (Group)

Early in the course, students will form groups of 3 or 4 to work in the both course projects. Both projects involve creating a system that visualize a dataset (provided by the instructor), and a short paper describing the system (see section 10.4.4 for details about the papers).

10.4.1 First Project: Information Visualization

In the first project will focus on **designing and implementing a functional** dashboard for a dataset, to create an interactive visualization system based on two-dimensional graphic representations. The system should be accessible online, using technologies such as D3.js. D3 stands for Data-Driven Documents, it is a JavaScript library for manipulating documents based on data. More information is available at https://d3js.org/

Each group will have a dataset assigned to them by the instructor. If a group wants to use a different dataset, they must first ask for the approval of the instructor.

10.4.2 Final Project: Visualization in XR

For the final project, groups will **design and implement a functional interactive visualization system** that illustrates how their interactive visualizations support the goals of the target users. It is also expected to conduct a basic system evaluation. This system must be created using an eXtended Reality (XR) technology such as Virtual Reality (VR), Augmented Reality (AR), or Mixed Reality (MR). The system can be implemented in platforms such as Babylon.js (https://www.babylonjs.com/) or Unity (https://learn.unity.com/).

Groups have the option to propose their own idea for their final project. However, this idea needs to be approved by the instructor. In case that the group cannot decide on an idea, they will be a dataset by the instructor.

10.4.3 Projects Presentation and Demonstration

The purpose of the presentations and demonstrations is to showcase the students' capacity to communicate their work in a professional presentation and demonstration session. Each group will have 15 minutes total for both their presentation and demonstration. The demonstration can be a video of the system, or a live session using the system.

10.4.4 Project Papers

The purpose of a paper is to show the students' capacity to communicate their work in writing. It must be scholarly structured, have a **coherent story and convincing argumentation**.

Final papers are due on the day of the Project Presentation

The papers must be written as if it was going to be submitted to a conference such as IEEE Vis, CHI, UIST, etc. As such, papers must follow the specifications set by the particular conference, including using the appropriate format.

Project paper must be 4 pages long, following the professional format of the conference (ACM, or IEEE). Papers must have an appropriate number of references (15+). Groups are encouraged to use the reading assignments as well as additional papers that were not covered in class.

11 Writing Guidelines for Papers and Reports

- **FOLLOW THE FORMATTING GUIDELINES.**
- **Proof read your paper**. Proper spelling and grammar is expected.
- **Write a good abstract**. The abstract should allow readers and reviewers to make a first assessment of the paper quickly. Some people recommend having four sentences in the abstract: The first states the problem. The second states why the problem is a problem. The third is the startling sentence (the discovery, solution, or contribution). The fourth states the implication of the startling sentence.
- **Papers should be self-contained**. All the contents and argumentation should be included in the paper without assuming the existence of appendices. If you wish to provide additional information, you can publish your appendices on the Web and provide a reference to the URL's in the reference section or as a footnote.
- **Provide a convincing argumentation**. Authors have to present and argue for their ideas in a convincing and coherent manner.
- **Support your claims.** When making claims or presenting design decisions, it is not sufficient to just present them. It is necessary to support your claims, provide references and justify your design decisions.
- **Structure your paper properly**. It is expected that the papers are properly structured into sections and subsections.
- **Provide all required sections**, including Categories and Subject Descriptions, General Terms, and Keywords.
- **Encapsulate concepts into paragraphs**. Avoid having overly long paragraphs. Short paragraphs make the paper more accessible and give readers more places where to stop and think about the concepts and ideas expressed in the paper.
- **The reading should flow**. Do not write the paper as bullet list or telegraph.
- **Avoid having empty sections** between headings and subheadings (e.g., having the heading for section 5.1 immediately after the heading for section 5 with no text in between). This usually means that there is a missing introduction/overview of the whole section, or that the paper can be structured and organized better.
- **Respect the copyright notice space**. You can modify or delete the text of the copyright notice, but respect the space allocated for the notice. When publishing a paper, the copyright notice will be added, shifting the rest of the text, which in turn can cause annoying layout issues (e.g., figures out of place, etc.).
- **Respect the specified length of the papers**. The maximum number of pages is all you get. Documents longer than the maximum page limit are not appropriate. Shorter papers indicate a lack of content.
- **Check your references.** Format your references appropriately.

Think about the communicative goals for your paper and your target audience

12 Reading Assignments

General

1. Stephen Few. "Data Visualization for Human Perception" https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/data-visualization-for-human-perception?cm_mc_sid_50200000=1497196827&cm_mc_uid=13918417820714971968273

2. Ben Shneiderman. "The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations." https://ieeexplore-ieee-org.ezproxy.lib.utexas.edu/document/545307

3. Jock Mackinlay. "Automating the Design of Graphical Presentations of Relational Information." https://dl.acm.org/doi/abs/10.1145/22949.22950?casa_token=9XzxTbXZLAIAAAAA:0OK2vsX3zqjUvIIZ1ZPrxhImTyKmJbxfR4YszTIuP4vsSjxb4kvCU8qAd1PdQqEs0I1ViFGrwj0

Best Paper Awards

4. (Best VAST paper award)
   Liang Gou, Lincan Zou, Nanxiang Li, Michael Hofmann, Shekar Arvind Kumar, Axel Wendt, and Liu Ren . "VATLD: A Visual Analytics System to Assess, Understand and Improve Traffic Light Detection"
   https://virtual.ieeevis.org/paper_f-vast-1307.html

5. (Best InfoVis Paper Award)
   Alex Kale, Matthew Kay, and Jessica Hullman. "Visual Reasoning Strategies and Satisficing: How Uncertainty Visualization Design Impacts Effect Size Judgments and Decisions" https://arxiv.org/pdf/2007.14516.pdf

6. (Best SciVis Paper Award)
   Rautek P, Mlejnek M, Beyer J, Troidl J, Pfister H, Theußl T, and Hadwiger M. "Objective Observer-Relative Flow Visualization in Curved Spaces for Unsteady 2D Geophysical Flows" *IEEE Transactions on Visualization and Computer Graphics (Proceedings IEEE Scientific Visualization 2020)*, 2021.
   https://vcg.seas.harvard.edu/publications/observer-relative-flow

Conceptual Visualization

7. Eva Murray. "Data Visualization And The Power Of Persuasion" https://www.forbes.com/sites/evamurray/2019/02/11/data-visualization-and-the-power-of-persuasion/?sh=491301734612

8. Scott Berinato. “Visualizations That Really Work: Know what message you’re trying to communicate before you get down in the weeds” https://hbr.org/2016/06/visualizations-that-really-work

9. J. Heer, M. Bostock, and V. Ogievetsky. "A Tour Through the Visualization Zoo." https://dl-acm-org.ezproxy.lib.utexas.edu/doi/abs/10.1145/1743546.1743567

Gestalt, Color

10. Stephanie Zeller, Francesca Samsel, and Paul Navártil. 2020. Environmental Visualization: Moving Beyond the Rainbows. In Practice and Experience in Advanced Research Computing (PEARC '20). Association for Computing Machinery, New York, NY, USA, 321–326. DOI: https://doi.org/10.1145/3311790.3396667

11. Michael Yi. “How to Choose Colors for Your Data Visualizations” https://medium.com/nightingale/how-to-choose-the-colors-for-your-data-visualizations-50b2557fa335

12. Dejan Todorovic. “Gestalt principles”. (2008), Scholarpedia, 3(12):5345. http://www.scholarpedia.org/article/Gestalt_principles

D3

13. Mike Bostock. “D3 Tutorial” (read the whole tutorial) https://observablehq.com/@d3/learn-d3

Data Formats, Wrangling

14. Sean Kandel, Andreas Paepcke, Joseph Hellerstein, and Jeffrey Heer. 2011. Wrangler: interactive visual specification of data transformation scripts. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '11). Association for Computing Machinery, New York, NY, USA, 3363–3372. DOI: https://doi.org/10.1145/1978942.1979444

15. Xu Chu, Ihab F. Ilyas, Sanjay Krishnan, and Jiannan Wang. 2016. Data Cleaning: Overview and Emerging Challenges. In Proceedings of the 2016 International Conference on Management of Data (SIGMOD '16). Association for Computing Machinery, New York, NY, USA, 2201–2206. DOI: https://doi.org/10.1145/2882903.2912574

16. Amy X. Zhang, Michael Muller, and Dakuo Wang. 2020. How do Data Science Workers Collaborate? Roles, Workflows, and Tools. Proc. ACM Hum.-Comput. Interact. 4, CSCW1, Article 022 (May 2020), 23 pages. DOI: https://doi-org.ezproxy.lib.utexas.edu/10.1145/3392826

17. W3Schools. “Jason Tutorial” (Read the 11 Web pages! Click on the “Next button”)
https://www.w3schools.com/js/js_json_intro.asp

Scientific Visualization

18. Ben Shneiderman. 2008. Extreme visualization: squeezing a billion records into a million pixels. In <i>Proceedings of the 2008 ACM SIGMOD international conference on Management of data</i> (<i>SIGMOD '08</i>). Association for Computing Machinery, New York, NY, USA, 3–12. DOI: https://doi-org.ezproxy.lib.utexas.edu/10.1145/1376616.1376618

19. Minju Kim, Jungjin Lee, Wolfgang Stuerzlinger, and Kwangyun Wohn. 2016. HoloStation: augmented visualization and presentation. In SIGGRAPH ASIA 2016 Symposium on Visualization (SA '16). Association for Computing Machinery, New York, NY, USA, Article 12, 1–9. DOI: https://doi-org.ezproxy.lib.utexas.edu/10.1145/3002151.3002161

20. Hayet Hadjar, Abdelkrim Meziane, Rachid Gherbi, Insaf Setitra, and Noureddine Aouaa. 2018. WebVR based Interactive Visualization of Open Health Data. In <i>Proceedings of the 2nd International Conference on Web Studies</i> (<i>WS.2 2018</i>). Association for Computing Machinery, New York, NY, USA, 56–63. DOI:
https://doi-org.ezproxy.lib.utexas.edu/10.1145/3240431.3240442

Visualization and Accessibility

21. Emeline Brule, Gilles Bailly, Anke Brock, Frederic Valentin, Grégoire Denis, and Christophe Jouffrais. 2016. MapSense: Multi-Sensory Interactive Maps for Children Living with Visual Impairments. In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16). Association for Computing Machinery, New York, NY, USA, 445–457. DOI: https://doi-org.ezproxy.lib.utexas.edu/10.1145/2858036.2858375
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22. Tania Calle-Jimenez and Sergio Luján-Mora. 2016. Accessible Online Indoor Maps for Blind and Visually Impaired Users. In <i>Proceedings of the 18th International ACM SIGACCESS Conference on Computers and Accessibility</i> (<i>ASSETS '16</i>). Association for Computing Machinery, New York, NY, USA, 309–310. DOI:
https://doi-org.ezproxy.lib.utexas.edu/10.1145/2982142.2982201

23. Anke M. Brock, Jon E. Froehlich, João Guerreiro, Benjamin Tannert, Anat Caspi, Johannes Schöning, and Steve Landau. 2018. SIG: Making Maps Accessible and Putting Accessibility in Maps. In <i>Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems</i> (<i>CHI EA '18</i>).

Association for Computing Machinery, New York, NY, USA, Paper SIG03, 1–4. DOI: https://doi-org.ezproxy.lib.utexas.edu/10.1145/3170427.3185373

24. Hasan Shahid Ferdous, Thuong Hoang, Zaher Joukhadar, Martin N. Reinoso, Frank Vetere, David Kelly, and Louisa Remedios. 2019. "What's Happening at that Hip?": Evaluating an On-body Projection based Augmented Reality System for Physiotherapy Classroom. In <i>Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems</i> (<i>CHI '19</i>). Association for Computing Machinery, New York, NY, USA, Paper 234, 1–12. DOI: https://doi-org.ezproxy.lib.utexas.edu/10.1145/3290605.3300464

Authoring XR

25. Andreas Bærentzen, Jeppe Revall Frisvad, and Karan Singh. 2019. Signifier-Based Immersive and Interactive 3D Modeling. In 25th ACM Symposium on Virtual Reality Software and Technology (VRST '19). Association for Computing Machinery, New York, NY, USA, Article 18, 1–5. DOI: https://doi-org.ezproxy.lib.utexas.edu/10.1145/3359996.3364257

26. Mario Sormann, Joachim Bauer, Christopher Zach, Andreas Klaus, and Konrad Karner. 2004. VR modeler: from image sequences to 3D models. In Proceedings of the 20th Spring Conference on Computer Graphics (SCCG '04). Association for Computing Machinery, New York, NY, USA, 148–156. DOI: https://doi-org.ezproxy.lib.utexas.edu/10.1145/1037210.1037233

27. Rahul Arora, Rubaiat Habib Kazi, Tovi Grossman, George Fitzmaurice, and Karan Singh. 2018. SymbiosisSketch: Combining 2D & 3D Sketching for Designing Detailed 3D Objects in Situ. In <i>Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems</i> (<i>CHI '18</i>). Association for Computing Machinery, New York, NY, USA, Paper 185, 1–15. DOI: https://doi-org.ezproxy.lib.utexas.edu/10.1145/3173574.3173759

28. Yongjae Lee, Changhyun Moon, Heedong Ko, Soo-Hong Lee, and Byounghyun Yoo. 2020. Unified Representation for XR Content and its Rendering Method. In <i>The 25th International Conference on 3D Web Technology</i> (<i>Web3D '20</i>). Association for Computing Machinery, New York, NY, USA, Article 21, 1–10. DOI: https://doi-org.ezproxy.lib.utexas.edu/10.1145/3424616.3424695