CSCE 5320: Scientific Data Visualization

Spring 2024

Course Information & Syllabus

Instructor: Zeenat Tariq

Office: E235M Discovery Park

Office timings: T/Th 4:30 PM - 5:30 PM (by appointment)

Email: zeenat.tariq@unt.edu

Course Description

This course is all about data visualization, the art, and the science of turning data into readable graphics. We’ll explore how to design and create data visualizations based on data available and tasks to be achieved. This process includes data modeling, data processing (such as aggregation and filtering), mapping data attributes to graphical attributes and strategic visual encoding based on known properties of visual perception as well as the task(s) at hand. Students will also learn to evaluate the effectiveness of visualization designs, and think critically about each design decision, such as choice of color and choice of visual encoding. Students will create their own data visualizations, and learn to use Open-Source data visualization tools such as Tableau, Power BI, D3.js, and python libraries. Students will also read papers from the current and past visualization literature and create video presentations of their findings.

Learning Outcomes

By the completion of this course, learners will be able to:

- Design and create data visualizations using Tableau and PowerBI.
- Conduct exploratory data analysis using visualization.
- Craft visual presentations of data for effective communication.
- Use knowledge of perception and cognition to evaluate visualization design alternatives.
- Design and evaluate color palettes for a visualization based on principles of perception.
- Apply data transformations such as aggregation and filtering for visualization.
- Identify opportunities for the application of data visualization in various domains.
- Critique existing visualizations based on data visualization theory and principles.
- Use JavaScript with D3.js to develop interactive visualizations for the Web.
- Use python library for efficient visualization.
Course Prerequisites

- Machine Learning, Artificial Intelligence, or equivalent AI/ML, data analytics course experience
- Familiarity with Programming (for programming assignments) e.g., Python, Javascript, HTML, CSS etc.

Targeted audience: Graduate students from Computer Science and related areas.

Attendance: Attendance is essential for success in any endeavor, and it is the same for this graduate course. Consistency in attending classes is expected.

Textbook

Visualization Analysis and Design (Author: Tamara Munzner)

Other Reference Material

- Interactive Data Visualization for the Web by Scott Murray 2nd Edition (2017)
- The Grammar of Graphics by Leland Wilkinson
- ggplot2 Elegant Graphics for Data Analysis by Hadley Wickham

Tentative Topics (subject to change based on learning rate in class)

<table>
<thead>
<tr>
<th>Week</th>
<th>Dates</th>
<th>Topics</th>
<th>Description</th>
<th>Due</th>
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<tbody>
<tr>
<td>1</td>
<td>Jan 15 - 20</td>
<td>Overview of Data Visualization</td>
<td>Why Visualize Data?</td>
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<td></td>
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<td>Getting started with the tools</td>
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<td>2</td>
<td>Jan 21 - 27</td>
<td>Data Abstraction. Introduction to Tableau</td>
<td>Build data visualizations in Tableau</td>
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<td>3</td>
<td>Jan 28 - Feb 3</td>
<td>Task Abstraction. Creating Visualizations in Tableau</td>
<td>Use data hierarchies, filters, groups, sets, and calculated fields.</td>
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<td>Create map-based data visualizations in Tableau</td>
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<td>4</td>
<td>Feb 4 - 10</td>
<td>Nested Model</td>
<td>Create and use the data calculated fields.</td>
<td>Project idea/Proposal</td>
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<td>Creation of sets and groups</td>
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<td>5</td>
<td>Feb 11 - 17</td>
<td>Introduction to Power BI</td>
<td>Build data visualizations in Power BI</td>
<td>Quiz 1</td>
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<tr>
<td>#</td>
<td>Date</td>
<td>Topic</td>
<td>Content</td>
<td>Assignments</td>
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<td>6</td>
<td>Feb 18 - 24</td>
<td>The Shapes of Data</td>
<td>Input for Visualization: Data and Tasks</td>
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<td>Interactivity with text and visual tooltips using Power BI</td>
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<tr>
<td>7</td>
<td>Feb 25 - Mar 2</td>
<td>Introduction to Web Technologies</td>
<td>Introduction to SVG and CSS.</td>
<td>Assignment 1</td>
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<td>Introduction to JavaScript.</td>
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<td>Introduction to VizHub.</td>
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<td>Making a Face with D3.js</td>
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<td>Loading and Parsing Data with D3.js</td>
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<td>8</td>
<td>Mar 3 - 9</td>
<td>Marks and Channels</td>
<td>Encoding Data with Marks and Channels</td>
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<td>Rendering Marks and Channels with D3.js and SVG</td>
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<td>Introduction to D3 Scales</td>
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<td>Creating a Scatter Plot with D3.js</td>
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<td>9</td>
<td>Mar 10 - 16</td>
<td>Spring Break</td>
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<td>10</td>
<td>Mar 17 - 23</td>
<td>Common Visualization Idioms</td>
<td>Reusable Dynamic Components using the General Update Pattern</td>
<td>Quiz 2</td>
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<td>Reusable Scatter Plot</td>
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<td>Common Visualization Idioms with D3.js</td>
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<td>9</td>
<td>Mar 24 - 30</td>
<td>Common Visualization Idioms(II)</td>
<td>Bar Chart, Vertical &amp; Horizontal</td>
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<td>Pie Chart and Coxcomb Plot</td>
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<td>Line Chart</td>
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<td>Area Chart</td>
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<td>10</td>
<td>Mar 31 - Apr 6</td>
<td>Visualization of Spatial Data, Networks, and Trees</td>
<td>Making Maps</td>
<td>Assignment 2</td>
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<td>Visualizing Trees and Networks</td>
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<td>11</td>
<td>Apr 7 - Apr 13</td>
<td>Using Color and Size in Visualization</td>
<td>Encoding Data using Color</td>
<td>Quiz 3</td>
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### Course Requirements

**Quizzes, Participation activities (hands on experience), Assignment, Conceptual Presentation**

**Quizzes**: These quizzes/exams are meant to focus students on the important aspects of the readings or lectures. You will be allowed to take the open book quizzes on canvas. You will be notified about the quiz one week prior taking it.

**Participation activities**: Activities are designed to engage you in your learning, so you can begin to apply these principles in practice and tailor them to your needs. You will get hands on different concepts/examples required for effective visualization using softwares/tools and
languages. Your participation in activities will be counted towards your final grade. There will be no specific due dates for the activities. The activities will be given during the class session and expected to be completed during that time. However, if some students are unable to attend the session, they can complete it remotely.

**Assignments:** There will be 2/3 assignments in the semester. The due date will be specified once the assignment is posted. Reports are to be turned in as PDF. Code is to be turned in with both Jupyter notebook and PDF form, along with any files necessary to run your assignment. Results should be presentable, with appropriate comments for someone to follow what you have done. All assignments must be turned in individually, although students are encouraged to work together extensively.

**Presentations (Conceptual):** After a few weeks into the course, you will be working on conceptual idea and present the work by the end of semester. You are required to work individually, as this is part of a full and complete education. This is your opportunity to demonstrate what you have learned in a way that reaches beyond the selection of tools, data sets, and approaches demonstrated in the course. Commonly students find a unique, complex data set and associated learning problem and apply the techniques presented in the class. The goal here is to create a coherent, completed work for presentation at the end of class. Essentially ask yourself what you would want to show an employer (or brag about to others) demonstrating what you have learned in the course.

**Exam:** There will be one final Exam (closed book) and taken in class in person. Exam cannot be missed without prior arrangements or later documented proof of extenuating circumstances.

**Grading**

Grades are determined by a simple points system, with a total of *at least* 100 pts as the goal though more than 100 points are likely. The expected distribution of points is given below, with the exact scale determined by point values given for each component - this is subject to minor modification based on actual points given.

- 25% Participation activities
- 20% Assignments (2)
- 25% Presentation (Project Presentation)
- 15% Quizzes (Open book 3-4)
- 15% Exam
- Bonus (Possible one extra credit activity)

**Grading Scale:** A=90, B=80-89, C=70-79, D=60-69, F=0-59 pts. No exceptions. If class grades are low (e.g., I expect most students will end with A’s and B’s), rescaling of some of the components or extra assignment will be given to add points to the class.
UNT Policies

Academic Integrity Policy

Academic Integrity Standards and Consequences. According to UNT Policy 06.003, Student Academic Integrity, academic dishonesty occurs when students engage in behaviors including, but not limited to cheating, fabrication, facilitating academic dishonesty, forgery, plagiarism, and sabotage. A finding of academic dishonesty may result in a range of academic penalties or sanctions ranging from admonition to expulsion from the University.

ADA Policy

UNT makes reasonable academic accommodation for students with disabilities. Students seeking accommodation must first register with the Office of Disability Accommodation (ODA) to verify their eligibility. If a disability is verified, the ODA will provide a student with an accommodation letter to be delivered to faculty to begin a private discussion regarding one’s specific course needs. Students may request accommodations at any time, however, ODA notices of accommodation should be provided as early as possible in the semester to avoid any delay in implementation. Note that students must obtain a new letter of accommodation for every semester and must meet with each faculty member prior to implementation in each class. For additional information see the ODA website (https://disability.unt.edu/).

Emergency Notification & Procedures

UNT uses a system called Eagle Alert to quickly notify students with critical information in the event of an emergency (i.e., severe weather, campus closing, and health and public safety emergencies like chemical spills, fires, or violence). In the event of a university closure, please refer to Blackboard for contingency plans for covering course materials.

Retention of Student Records

Student records pertaining to this course are maintained in a secure location by the instructor of record. All records such as exams, answer sheets (with keys), and written papers submitted during the duration of the course are kept for at least one calendar year after course completion. Course work completed via the Blackboard online system, including grading information and comments, is also stored in a safe electronic environment for one year. Students have the right to view their individual record; however, information about student’s records will not be divulged to other individuals without proper written consent. Students are encouraged to review the Public Information Policy and the Family Educational Rights and Privacy Act (FERPA) laws and the University’s policy. See UNT Policy 10.10, Records Management and Retention for additional information.

Acceptable Student Behavior
Student behavior that interferes with an instructor’s ability to conduct a class or other students' opportunity to learn is unacceptable and disruptive and will not be tolerated in any instructional forum at UNT. Students engaging in unacceptable behavior will be directed to leave the classroom and the instructor may refer the student to the Dean of Students to consider whether the student's conduct violated the Code of Student Conduct. The University's expectations for student conduct apply to all instructional forums, including University and electronic classroom, labs, discussion groups, field trips, etc. Visit UNT’s Code of Student Conduct (https://deanofstudents.unt.edu/conduct) to learn more.

Access to Information - Eagle Connect

Students’ access point for business and academic services at UNT is located at: my.unt.edu. All official communication from the University will be delivered to a student’s Eagle Connect account. For more information, please visit the website that explains Eagle Connect and how to forward e-mail Eagle Connect (https://it.unt.edu/eagleconnect).

Student Evaluation Administration Dates

Student feedback is important and an essential part of participation in this course. The student evaluation of instruction is a requirement for all organized classes at UNT. The survey will be made available during weeks 13, 14 and 15 of the long semesters to provide students with an opportunity to evaluate how this course is taught. Students will receive an email from "UNT SPOT Course Evaluations via IASystem Notification" (no-reply@iasystem.org) with the survey link. Students should look for the email in their UNT email inbox. Simply click on the link and complete the survey. Once students complete the survey they will receive a confirmation email that the survey has been submitted. For additional information, please visit the SPOT website (http://spot.unt.edu/) or email spot@unt.edu.

Getting Help

Technical Assistance

UIT Help Desk (http://www.unt.edu/helpdesk/index.htm)

Email: helpdesk@unt.edu

Phone: 940-565-2324

In Person: Sage Hall, Room 130

Walk-In Availability: 8am-9pm

Telephone Availability:

- Sunday: noon-midnight
- Monday-Thursday: 8am-midnight
• Friday: 8am-8pm  
• Saturday: 9am-5pm

Laptop Checkout: 8am-7pm

Student Support Services

• Registrar (https://registrar.unt.edu/registration)  
• Financial Aid (https://financialaid.unt.edu/)  
• Student Legal Services (https://studentaffairs.unt.edu/student-legal-services)  
• Career Center (https://studentaffairs.unt.edu/career-center)  
• Multicultural Center (https://edo.unt.edu/multicultural-center)  
• Counseling and Testing Services (https://studentaffairs.unt.edu/counseling-and-testing-services)  
• Student Affairs Care Team (https://studentaffairs.unt.edu/care)  
• Student Health and Wellness Center (https://studentaffairs.unt.edu/student-health-and-wellness-center)  
• Pride Alliance (https://edo.unt.edu/pridealliance)

Academic Support Services

• Academic Resource Center (https://clear.unt.edu/canvas/student-resources)  
• Academic Success Center (https://success.unt.edu/asc)  
• UNT Libraries (https://library.unt.edu/)  
• Writing Lab (http://writingcenter.unt.edu/)  
• MathLab (https://math.unt.edu/mathlab)