INST 462 - Introduction to Data Visualization

Syllabus - Section 0102

- **Course name:** INST 462 - Introduction to Data Visualization
- **Course hours:** TuTh 9:30am - 10:45am
- **Room**: PHYS 0405
- **Term:** Fall 2018
- **Instructor:** Dr. Niklas Elmqvist
  - **E-mail:** elm@umd.edu
- **Textbook:** Tamara Munzner, *Visualization Analysis and Design* (VAD), CRC press, 2014. (http://www.cs.ubc.ca/~tmm/vadbook/)

Introduction

Data visualization is the graphical representation of data to aid understanding, and is the key to analyzing big data for fields such as science, engineering, medicine, and the humanities. This undergraduate course is an introduction to data visualization, where you will learn how to design, build, and evaluate visualizations for different types of data, disciplines, and domains.

The course has a strong emphasis on design and practical applications of data visualization. The format for the course will be lectures by the instructor, practical design exercises, group discussions, as well as a set of practical assignments throughout the course. The grading will be based on participation in class and assignments.

Student Learning Outcomes

Upon successful completion of the course, students will be able to:

- Articulate human, visual, and interactive design issues for creating effective visualizations.

- Use existing visualization tools and techniques to analyze basic datasets.

- Apply existing techniques from scalar, volume, multidimensional, textual, graph-based, tree-based, and temporal visualization to actual problems and data.

- Evaluate a visualization solution based on quantitative metrics such as time and error, as well as more complex and qualitative metrics.

- Articulate issues and techniques for applying visualization to domains such as medicine, finance, science, engineering, the humanities, policy, and government.

Grading

The course outcomes will be assessed through the following mechanisms:

- **Visualization assignments** (80%) - practical assignments on data visualization, including visual and interactive design, cognition, and data transformation.

- **Class participation** (20%) - in-class activities such as design sessions, quizzes, and presentations by students.

Final grades will be assigned using the following categories:

A+	More than 97.0	**C**	73.0 - 76.9
A	93.0 - 96.9	**C-**	70.0 - 72.9
A-	90.0 - 92.9	**D+**	67.0 - 69.9
B+	87.0 - 89.9	**D**	63.0 - 66.9
B	83.0 - 86.9	**D-**	60.0 - 62.9
B-	80.0 - 82.9	**F**	Less than 60
C+	77.0 - 79.9		

Assignments

Biweekly assignments where students work on practical visualization problems will be a major part of the course. These assignments are worth 10% of the final grade each, and are designed to be relatively lightweight. The goal is to expose the student to as many practical visualization techniques and problems as possible. Here is an overview:

- **Assignment 1: Infographics** - create a simple infographic about your own life and career. (10%)
- **Assignment 2: Basic Visualization Design** - designing a new visualization technique. (10%)
- **Assignment 3: Tableau** - use Tableau to analyze multidimensional data. (10%)
- **Assignment 4: Gephi** - use Gephi to analyze network data. (10%)
- **Assignment 5: Keshif** - use Keshif to analyze tabular data. (10%)

- **Assignment 6: R and Jupyter Notebooks** - use R and/or Python in Jupyter Notebooks. (10%)
- **Assignment 7: Data Illustrator** - use the Adobe Data Illustrator tool. (10%)
- **Assignment 8: Data-Driven Storytelling** - create a data-driven story using visualization about a dataset. (10%)

Detailed Schedule

See below for a list of topics and readings for the class meetings of INST 462.

Lecture	Topic	Readings
Lecture #1	**Introduction** Course organization Introduction to visualization The visualization pipeline	None.
Lecture #2	**The Value of Visualization** What's Vis, and Why Do It?	Chapter 1 (VAD)
Lecture #3	**Data** Why Do Data Semantics and Types Matter? Data Types Dataset Types Attribute Types Semantics	Chapter 2 (VAD)
Lecture #4	**Tools I - Excel**	None.
Lecture #5	**Tasks** Why Analyze Tasks Abstractly? Who: Designer or User Actions Targets How: A Preview	Chapter 3 (VAD)
Lecture #6	**Validation** Why Validate? Four Levels of Design Angles of Attack Threats and Validation Approaches Validation Examples	Chapter 4 (VAD)
Lecture #7	**Marks and Channels** Why Marks and Channels? Defining Marks and Channels Using Marks and Channels Channel Effectiveness	Chapter 5 (VAD)

	Relative vs. Absolute Judgments	
Lecture #8	**Tools II - Tableau**	None.
Lecture #9	**Design Guidelines** Why and When to Follow Rules of Thumb? No Unjustified 3D No Unjustified 2D Eyes Beat Memory Resolution over Immersion Overview First, Zoom and Filter, Details on Demand Responsiveness Is Required Get It Right in Black and White Function First, Form Next	Chapter 6 (VAD)
Lecture #10	**Tables** Why Arrange? Classifying Arrangements by Keys and Values Express: Quantitative Values Separate, Order, and Align: Categorical Regions Spatial Axis Orientation Spatial Layout Density	Chapter 7 (VAD)
Lecture #11	**Networks and Trees** Connection: Link Marks Matrix Views Costs and Benefits: Connection vs. Matrix Containment: Hierarchy	Chapter 9 (VAD)
Lecture #12	**Tools III - Gephi**	None.
Lecture #13	**Spatial Data** Why Use Given? Geometry Scalar Fields: 1 Value Vector Fields: Multiple Values Tensor Fields: Many Values	Chapter 8 (VAD)
Lecture #14	**Color** Color Theory Colormaps Other Channels	Chapter 10 (VAD)
Lecture #15	**Facets and Views** Why Facet?	Chapter 12 (VAD)

	Juxtapose and Coordinate Views Partition into Views Superimpose Layers	
Lecture #16	**Tools IV - Keshif**	None.
Lecture #17	**Interaction and Navigation** Why Change? Change View over Time Select Elements Navigate: Changing Viewpoint Navigate: Reducing Attributes	Chapter 11 (VAD)
Lecture #18	**Tools V - R and Jupyter Notebooks**	None.
Lecture #19	**Data Reduction** Why Reduce? Filter Aggregate	Chapter 13 (VAD)
Lecture #20	**Tools VI - Adobe Data Illustrator**	None.
Lecture #21	**Case Studies** Case studies from VAD and elsewhere.	Chapter 15 (VAD)
Lecture #22	**Textual Data** Words and text visualization Document visualization	None.
Lecture #23	**Temporal Data** Continuous time-series visualization Discrete event visualization	None.
Lecture #24	**Storytelling** Data-driven storytelling Storytelling media Examples of data-driven storytelling	None.
Lecture #25	**Tools VI - D3 and VEGA**	None.
Lecture #26	**Beyond the Desktop** Novel input and output platforms	None.
Lecture #27	**Collaboration** Collaborative visualization Co-located collaboration Distributed collaboration	None.
Lecture #28	**Presentations I**	None.

	Presentations for storytelling assignment	
Lecture #29	**Presentations II** Presentations for storytelling assignment	None.

Additional Information and Policies

Please see the [UMD Undergraduate Course Policies](#) for general information and policies with regard to undergraduate courses at the University of Maryland. Furthermore, see below for course-specific information.

Academic Integrity

Academic dishonesty is a corrosive force in the academic life of a university. It jeopardizes the quality of education and depreciates the genuine achievements of others. Apathy or acquiescence in the presence of academic dishonesty is not a neutral act. All members of the university community - students, faculty, and staff - share the responsibility to challenge and make known acts of apparent academic dishonesty.

Students have a responsibility to familiarize themselves with violations of the [UMD Code of Academic Integrity](#). Among these include:

- Cheating: "Intentionally using or attempting to use unauthorized materials, information, or study aids in any academic exercise."

- Fabrication: "Intentional and unauthorized falsification or invention of any information or citation in an academic exercise."

- Facilitating Academic Dishonesty: "Intentionally or knowingly helping or attempting to help another to commit an act of academic dishonesty."

- Plagiarism: "Intentionally or knowingly representing the words or ideas of another as one's own in an academic exercise."

Attendance Policy

Please note that the class meetings are vital part of the learning for this course. During class meetings, the instructor will not only lecture on the topic of the course, but there will also be a considerable amount of discussion, group work, and student involvement. Please do your best to attend

Having said that, I will not be taking attendance during class unless many students are choosing not to participate in class meetings on a routine basis.

University policy excuses the absences of students for illness, religious observances, participation in University activities at the request of university authorities, and compelling circumstances beyond the student's control. Students who miss a single class for a medical reason are not required to provide medical documentation, but students who are absent more than once are responsible for providing various forms of documentation, depending on the nature of the absence.

Course Evaluation

Class evaluations are the best way for the university and the individual instructor to improve their course for next year. Please take a moment to participate in the course evaluation at the end of the semester.

Course evaluations are a part of the process by which the University of Maryland seeks to improve teaching and learning. The University Senate approved the implementation of a standard, online, university-wide course evaluation instrument. Each course evaluation contains a set of universal questions, and some are supplemented by questions from specific colleges. Students who leave no "Pending" evaluations in their Evaluation Dashboard each semester can view the aggregate results of a sub-set of universal items online.

Across the University, course evaluations are being administered through a web-based system dubbed CourseEvalUM. All information submitted to the Evaluation System is confidential. Instructors and academic administrators can only view summarized evaluation results after final grades have been submitted. Instructors and academic administrators cannot identify which submissions belong to which students. This standardized set of evaluation results provides the University with useful information on teaching and student learning across the campus.

For additional info see CourseEvalUM's website: https://www.courseevalum.umd.edu/

Emergency Preparedness

In our increasingly unstable world, there are many situations that may have an impact on the university's teaching mission. In the event of a major campus emergency, course requirements, deadlines, and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. Information about changes in this course can be received from the Canvas web page, or by contacting the instructor by email (elm@umd.edu) or by phone ((765) 418-5677).

More information here: https://prepare.umd.edu/

Extensions

If you have to miss a deadline, you should inform the instructor as soon as possible, indicating when you will submit your work. The instructor will try to accommodate your needs. You should use this clause only for extraordinary personal reasons (e.g., personal illness, death in the family, etc.). The general policy is that late work will be deducted 20% of its total grade per

calendar day, starting on the same day it is due. It is at the instructor's discretion to accept late work and assign late penalties.

Special Needs

Students with disabilities should inform the instructor of their needs at the beginning of the semester. Please also contact the Accessibility and Disability Services (301-314-7682 or http://www.counseling.umd.edu/ads/). ADS will make arrangements with the student and the instructor to determine and implement appropriate academic accommodations. Students encountering psychological problems that hamper their course work are referred to the Counseling Center (301-314-7651 or http://www.counseling.umd.edu/) for expert help.

Self Identifications

The University of Maryland recognizes the importance of a diverse student body, and we are committed to fostering equitable classroom environments. If you wish, please tell us how you want to be referred to both in terms of your name and your pronouns (he/him, she/her, they/them, etc.). The pronouns someone indicates are not necessarily indicative of their gender identity. Visit http://trans.umd.edu to learn more.

Additionally, how you identify in terms of your gender, race, class, sexuality, religion, and dis/ability, among all aspects of your identity, is your choice whether to disclose and should be self-identified, not presumed or imposed. The instructor will do their best to address and refer to all students accordingly, and you are asked to do the same for all of your fellow students.