

EN 605.662: Data Visualization

Syllabus

Instructor Contact

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Please use email to contact me. I will make every effort to respond to your inquiry within 48 hours. If an issue is urgent, please indicate "urgent" within the subject line of the email and I will respond as soon as is practical. For emergencies, feel free to call me.

Office Hours

This course will use Zoom to facilitate weekly, synchronous office hours. You are not required to participate in office hours; however, you may find them very beneficial for receiving more timely answers to questions related to the course content and assignments.

Office hours will be held Thursday of every week, from 7:00 – 8:00 PM. An email link will be provided for the Zoom meeting each Thursday morning. If you plan to attend office hours, please send me an email with your preferred time **and a brief synopsis of your discussion topic**. I will work with students to ensure one-on-one time to address questions.

Exceptions to this weekly time can be made. Email me for meeting requests outside office hours.

Course Description

As organization and individuals continue to rely more in data to make informed decisions, there has been an interest in studying effective ways to explore the information. Data visualization is a research area that focuses on the use of visualization techniques to help people understand and analyze data. When well-designed visualization tools are provided to users, they can take advantage of the powerful human cognitive capabilities and improve comprehension, memory, and inference. This multidisciplinary course introduces the practical concepts of graphic design related to data visualization and interactive design. This course explores the underlying theory and practical concepts in creating visual representations of heterogeneous data. It covers the core topics in data visualization including data representation, design principles, color, interaction, network visualization, cartography, volume rendering, and visual analytics.

Prerequisites

Students should be able to develop basic software applications in modern programming languages (R or Python) and should be familiar with the basic concepts of data processing and statistics. Some background in computer graphics, human computer interaction, or image processing is helpful but not required.

Course Goals

To learn practical concepts of graphic design related to data visualization and interactive design. This course will explore the underlying theory and practical concepts in creating visual representations of heterogeneous data. It will cover the core topics in data visualization including data representation, design principles, color, interaction, network visualization, cartography, volume rendering, and visual analytics. The new knowledge acquired during the semester will be used to solve practical data visualization and visual analytics problems.

Course Objectives

By the end of the course, students will be able to:

1. Describe the foundations of the human visual perception and how it relates to creating effective information visualizations.
2. Understand the design principles for creating effective visualization tools
3. Evaluate different visualization techniques and identify potential misleading charts and visualizations
4. Demonstrate familiarity of the visual design process by developing interactive data visualization tools
5. Understand different data types including tabular, hierarchical, geospatial, textual, and scalar and related visualization techniques to each data type
6. Show familiarity of existing data visualization tools and programming libraries

Course Structure

The course materials are divided into modules which can be accessed by clicking Course Modules on the left menu. A module will have several sections including the overview, lectures and content, readings, discussions, and assignments. You are encouraged to preview all sections of the module before starting. Modules run for a period of seven (7) days, any exceptions are noted on the Course Outline page.

Weekly modules will become available the Tuesday of each week. Module assignments are due Monday by 11:59 pm eastern time. I will announce any changes to due dates in the Calendar and Announcements sections of blackboard.

Textbook

Required

No required book for this course. Links to various chapters, papers, and resources will be shared throughout the semester.

Textbook information for this course is available online through the appropriate bookstore website: For online courses, search the MBS website at <http://ep.jhu.edu/bookstore>.

Optional (recommended)

Any of the following texts or other texts that you may have from previous courses may be useful for this course if you find yourself struggling with specific skills:

- *Interactive Data Visualization* by Matthew Ward, Georges Grinstein, Daniel Keim, AK Peters, 2010.
- *Information Visualization* by Chaomei Chen, Springer Verlag, 2004
- *Visualization Analysis and Design* by Tamara Munzner A K Peters Visualization Series, CRC Press, 2014
- *The Visual Display of Quantitative Information* by Edward Tufte, Graphics Press, 1983.
- *Visual Explanations* by Edward Tufte, Graphics Press, 1997.
- *Envisioning Information* by Edward Tufte, Graphics Press, 1990.

Technical Requirements

You should refer to Help & Support on the left menu for a general listing of all the course technical requirements.

Student Coursework Requirements

Each module should take approximately 7–10 hours per week to complete. With few exceptions, each week will include video lectures and corresponding slides, assigned readings, programming assignments, and the online discussion board.

This course will consist of three basic student requirements:

1. Participation (20% of Final Grade Calculation)

Participation will be graded based on quizzes after select modules and the discussion board.

Quizzes:

Some modules will have multiple choice quizzes at the end of the module to assess the student's comprehension of the material discussed during that lecture. Quizzes should only take a few minutes to complete and must be completed by the end of module. No time limit to complete the quizzes.

Module Discussions:

One of the most important components of this course is contribution to the discussion board. Each module will have a topic / question. To enable student interaction, students will be also required to provide a substantive response to at least 2 other students. Weekly discussion boards close on the Monday at 11:59 pm eastern, just prior to the opening of the next module

Participation is graded as follows:

Criteria	Excellent	Satisfactory	Unsatisfactory
Concise, Critical Thinking/ Reasoning	Student actively stimulates and sustains inquiry by asking or posting thoughtful questions or comments. Student recognizes accuracy, logic, relevance, or clarity of statements. Student has a clear idea of the topic under discussion and sustain inquiry by asking thoughtful questions. Responses are concise and reflect original thinking.	Student posts questions and comments, but relies on momentum of the group to motivate inquiry. Student may be repetitive with comments. Student takes a position but with little evidence or explanation. Responses are somewhat concise and logically organized, and reflect a mixture of original thinking and contributions from others.	Student accepts ideas of others without much thought. Student provides little relevant information or contributes little to the discussion. Student shows little evidence of understanding the topic under discussion. Responses are neither clear nor concise. Little or no original thinking is demonstrated.
Generates learning and engagement among classmates	Post(s) elicit responses and reflections from other learners and responses build upon and integrate multiple views from other learners to take the discussion deeper.	Post(s) attempt to elicit responses and reflections from other learners and responses build upon the ideas of other learners to take the discussion deeper.	Post(s) do not attempt to elicit responses and reflections from other learners and/or responses do not build upon the ideas of other learners to take the discussion deeper.
Demonstrates knowledge of content and applicability to professional practice	Post(s) and responses show evidence of knowledge and understanding of course content and applicability to professional practice, and include other resources that extend the learning of the community.	Post(s) and responses show evidence of knowledge and understanding of course content and applicability to professional practice.	Post(s) and responses show little evidence of knowledge and understanding of course content and applicability to professional practice.

Timeliness and Mechanics	Submits initial response before the end of Day 5 in module week; replies to classmates are meaningful.	Submits initial response before end of Day 6 in module week; replies to classmates are present, but superficial.	Submits initial response after Day 6 in module week; does not respond to classmates.
	Posts contain grammatically correct sentences without spelling errors.	Posts have one or more grammatical or spelling errors.	Posts are not in complete sentences and/or contain more than 5 spelling or grammatical errors.

2. Programming Assignments (50% of Final Grade Calculation)

Programming assignments will count for 50% of the final grade. They will be distributed throughout the semester to enable students in a hands-on experience of implementing visualization techniques to explore data. I prefer students use R or Python but will accept Tableau or other platforms by request.

Programming projects will be graded according to (a) the quality of the results and (b) the clarity of the source code. See generic rubric below that will be used to grade programming assignments.

<u>Critical Errors Program compiles and/or executes as expected</u> (0 to 20 points)	Program does not compile or runs correctly. Program executes and sometimes terminates with a segmentation fault. (0 to 15 points)	Program compiles and runs correctly. Program executes and terminates properly without crashing but produces some run time warnings. (15 to 20 points)	Program compiles and runs correctly. Program executes and terminates properly without crashing. (20 points)
<u>Submission Error Project submitted following guidelines</u> (0 to 10 points)	Submission is incomplete and does not include all requested files. (0 to 5 points)	Submission is mostly complete. Submission includes all requested files and for the most part follows the naming convention. (5 to 9 points)	Submission is complete. Submission includes all requested files and follows naming convention. (10 points)
<u>Correctness</u> Implementation logical and correct (0 to 30 points)	Program does not follow most of the requirements and the technical approach does not seem to be logical and correct. (0 to 14 points)	Program implemented following most of the requirements and the technical approach (with the exception of 1 to 2 components) seems to be logical and correct. (15 to 25 points)	Program implemented following requirements and the technical approach seems to be logical and correct. (25 to 30 points)
<u>Efficiency & Design:</u> Quality of Final Product (0 to 35 points)	Program is not efficient and/or only works with a small set of input images. Overall design is not clear and logical. (0 to 15 points)	Program is mostly efficient and most with multiple input images. Overall design is mostly clear, simple, and logical. (15 to 25 points)	Program is efficient and works with multiple input images. Overall design is clear, simple, and logical. (25 to 30 points)
<u>Documentation: Program Documentation</u> (0 to 10 points)	The source code is (for the most part) not documented. (0 to 5 points)	Source code documentation is not complete or reasonable. (5 to 8 points)	Source documentation is sufficient and reasonable. (8-10 points)

NOTE: Some programming assignments have a written section. That will be graded based on what is specified in each individual assignment.

3. Final Project (30% of Final Grade Calculation)

The final project is a significant part of the course. It allows students to synthesize the concepts learned throughout the semester and apply them to their own images and/or to their particular area of interest. The final project grades will be based on the following components:

- Draft Proposal (10%)
- Revised Proposal (10%)
- Literature survey (20%)
- Final paper (40%)
- Final program (20%)

See generic rubric below that will be used to grade the Final Project.

<u>Project Proposal</u> Draft Proposal and Revised Project Proposal <i>(0 to 20 points)</i>	Topic of the proposal not necessarily relevant to the class. Proposal does not include detailed description, project plan, or timeline. Revised proposal does not include some of the suggestions received from instructor. <i>(0 to 15 points)</i>	Topic of the proposal relevant to the class. Proposal includes description, project plan, and a rough timeline. Revised proposal does not include some of the suggestions received from instructor. <i>(15 to 20 points)</i>	Topic of the proposal relevant to the class. Proposal includes description, project plan, and detailed timeline. Revised proposal include some of the suggestions received from instructor. <i>(20 points)</i>
<u>Literature Survey</u> Annotated Bibliography <i>(0 to 20 points)</i>	Annotated bibliography that includes less than four references and each reference has a short description of the paper, approach and results. <i>(0 to 9 points)</i>	Annotated bibliography that includes at least four references and each reference has a short description of the paper, approach and results. <i>(10 to 18 points)</i>	Annotated bibliography that includes at least four references and each reference has a short, but accurate, description of the paper, approach and results. <i>(18 to 20 points)</i>
<u>Final Paper</u> Paper submission with describing final Project <i>(0 to 40 points)</i>	A paper that describes a good class project, technical approach, and different results. The paper has some grammatical errors or typos and does not include all the suggested sections. <i>(0 to 19 points)</i>	A well-written paper that describes a good class project, technical approach, and different results. The paper includes sections for introduction, background, approach, results, and conclusion. <i>(20 to 30 points)</i>	A well-written paper that describes an outstanding and comprehensive class project, technical approach, and different results. The paper includes sections for introduction, background, approach, results, and conclusion. <i>(30 to 40 points)</i>
<u>Final Project Code:</u> Code, images, and data used in final project. <i>(0 to 20 points)</i>	Program that compiles and performs most of what the student described in his/her final paper. The code has some documentation and the project follows most of the required naming convention. <i>(0 to 14 points)</i>	Good program that compiles and performs what the student described in his/her final paper. The code has some documentation and the project follows the required naming convention. <i>(10 to 15 points)</i>	Efficient program that compiles and performs what the student described in his/her final paper. The code has good documentation and the project follows the required naming convention. <i>(15 to 20 points)</i>

Grading

The course will consist of 14 modules. Each module will include a video lecture, corresponding slides, reading assignment, and an online discussion. The grading of this course will be based on:

Item	% of Grade
Class Participation	20%
Programming Assignments	50%
Final Project	30%

Programming assignments are due according to the dates posted in your Blackboard course site. You may check these due dates in the Course Calendar or the Assignments in the corresponding modules. I will post grades 1-2 weeks after assignment due dates. The code for your programming assignment must be submitted and should include enough documentation so we can read your code and understand the approach you are following.

In written sections and the final paper, we generally do not directly grade spelling and grammar. However, egregious violations of the rules of the English language will be noted without comment. Consistently poor performance in either spelling or grammar is taken as an indication of poor written communication ability that may detract from your grade.

Final grades will be assigned according to the following scale:

100–98 = A+
97–94 = A
93–90 = A–
89–87 = B+
86–83 = B
82–80 = B–
79–70 = C
<70 = F

A final grade of A indicates achievement of consistent excellence and distinction throughout the course—that is, conspicuous excellence in all aspects of assignments and discussion in every week.

A final grade of B indicates work that meets all course requirements on a level appropriate for graduate academic work.

Late policy:

- **Programming projects will be due at 11:59pm on the due date.**
- Students may turn in one programming assignment up to 24 hours late, however students must notify the instructor each time the special extension is used. Failure to notify the instructor and any additional day will result in a 10% penalty of the assignment grade.
- Penalty of 10% per day for projects submitted late.
- Additional exceptions for emergencies and medical conditions may be given if deemed appropriate.

Academic Integrity:

All programming assignments must be done individually unless explicitly instructed otherwise. Cheating and plagiarism will be dealt with in accordance with university procedures. For example, code for programming assignments must be developed and should not be obtained from anyone or anywhere, including the Internet. You are encouraged to use the

online discussion board to discuss with your peers approaches and techniques broadly, but not at a level of detail where specific implementation issues are described by anyone.

Help & Support

You should refer to Help & Support on the left menu for a listing of all the student services and support available.

Policies and Guidelines

Academic Misconduct Policy

You should read policies pertaining to academic misconduct and netiquette at <http://ep.jhu.edu/genpolguid>. Please read below how the Academic Misconduct Policy applies to your course.

Collaborations and discussions between students are key ingredients to success in a graduate course. You are encouraged to discuss the course material with each other as you sort through concepts that may be difficult to comprehend or controversial. However, the line between collaboration and cheating needs to be carefully delineated. Whenever you turn in work with your name on it to be evaluated, graded and included in your record it must represent an individual effort by you alone. If you include direct quotes from any source in your discussions, written assignments, the final exam, or any other submission for which you will receive a grade you must provide attribution. Students using published material without reference, or copying the work of another individual will receive a warning at the first incident. Any further incidents will result in the student receiving a zero on the assignment and the matter will be referred to the Associate Dean. Contact us if you have any questions, no matter how slight, about this policy, or if you have questions about a particular assignment.

Plagiarism

Plagiarism is defined as taking the words, ideas or thoughts of another and representing them as one's own. If you use the ideas of another, provide a complete citation in the source work; if you use the words of another, present the words in the correct quotation notation (indentation or enclosed in quotation marks, as appropriate) and include a complete citation to the source. See the course text for examples.

Policy on Disability Services

Johns Hopkins University (JHU) is committed to creating a welcoming and inclusive environment for students, faculty, staff and visitors with disabilities. The University does not discriminate on the basis of race, color, sex, religion, sexual orientation, national or ethnic origin, age, disability or veteran status in any student program or activity, or with regard to admission or employment. JHU works to ensure that students, employees and visitors with disabilities have equal access to university programs, facilities, technology and websites.

Under Section 504 of the Rehabilitation Act of 1973, the Americans with Disabilities Act (ADA) of 1990 and the ADA Amendments Act of 2008, a person is considered to have a disability if c (1) he or she has a physical or mental impairment that substantially limits one or more major life activities (such as hearing, seeing, speaking, breathing, performing manual tasks, walking, caring for oneself, learning, or concentrating); (2) has a record of having such an impairment; or (3) is regarded as having such an impairment class. The University provides reasonable and appropriate accommodations to students and employees with disabilities. In most cases, JHU will require documentation of the disability and the need for the specific requested accommodation.

The Disability Services program within the Office of Institutional Equity oversees the coordination of reasonable accommodations for students and employees with disabilities, and serves as the central point of contact for information on physical and programmatic access at the University. More information on this policy may be found at <http://web.jhu.edu/administration/jhuoie/disability/index.html> or by contacting (410) 516-8075.

Disability Services

Johns Hopkins Engineering for Professionals is committed to providing reasonable and appropriate accommodations to students with disabilities.

Students requiring accommodations are encouraged to contact Disability Services at least four weeks before the start of the academic term or as soon as possible. Although requests can be made at any time, students should understand that there may be a delay of up to two weeks for implementation depending on the nature of the accommodations requested.

Requesting Accommodation

New students must submit a [Student Request for Accommodation](#) form along with supporting documentation from a qualified diagnostician that:

- Identifies the type of disability
- Describes the current level of functioning in an academic setting
- Lists recommended accommodations

Questions about disability resources and requests for accommodation at Johns Hopkins Engineering for Professionals should be directed to:

Mark Tuminello

Disability Services Coordinator

Phone 410-516-2306

Fax 410-579-8049

E-mail mtumine2@jhu.edu or ep-disability-svcs@jhu.edu