Course Description  This course introduces material on the theory and practice of designing effective visualizations of data from numerous sources. A broad overview to the field is presented, covering principles, methods, and techniques that are foundational to both information and scientific visualization.

Data visualization is a field of growing importance that combines background expertise in computer graphics, scientific computing, data mining, and image processing. It couples these fields with artistic, psychological, perceptual, and interactivity concerns. The techniques learned in this class are broadly applicable to all fields in engineering and science, where the explosion of data we are now able to generate demands effective presentation and analysis.

Prerequisites  Students are expected to have basic programming skills and introductory knowledge of linear algebra and calculus. Completed material in computer graphics topics (e.g. CPSC 6040, 6050 or equivalent) is helpful but not required. Students majoring in areas other than CPSC are especially encouraged to enroll. Please contact the instructor if you are unsure if you satisfy the prerequisites.

Course Objectives  This course will provide a thorough grounding in the state of the art data visualization. It is designed to prepare students to:

- understand the role of visualization in the processing and analysis of data coming from a broad range of sources;
- develop software and tools to create visualizations of data that are effective for analysis;
- be familiar with the cutting edge research ideas in the field of visualization; and
- undertake creative work and perform research involving visualization topics.

Students will read and discuss relevant texts and research papers, as well as be evaluated using a series of programming projects involving cutting-edge data visualization libraries.

Required Text and Handout Materials
- Other handouts, research papers, and materials linked to on the course webpage: [http://people.cs.clemson.edu/~levinej/courses/8040](http://people.cs.clemson.edu/~levinej/courses/8040)

Additional Reference Reading Material
• Farin and Hansford, Mathematical Principles for Scientific Computing and Visualization, 2008, ISBN 156881321X (available electronically through the Clemson University libraries)
Content

Course Outline

I. Visualization Fundamentals
   • Design principles
   • The Process of Visualization
   • Data Abstraction
   • Visual Encodings
   • Use of Color
   • Perceptual Issues
   • Designing Views
   • Interacting with Visualizations
   • Filtering and Aggregation
   • Design Studies

II. Information / Non-Spatial Data Visualization
   • Tabular Data
   • Tree Data
   • Graph Data
   • Text Data
   • Flow Data
   • Time-Series Data
   • Topological Visualization
   • Uncertainty
   • Visual Analytics

III. Scientific / Spatial Data Visualization
   • Scalar Volumes
   • Isosurfacing
   • Volume Rendering
   • Transfer Function Design
   • Vector Fields
   • Maps
   • Spatial Uncertainty

IV. Software Tools for Visualization
Performance Evaluation

Grades will be assigned based on the following scale:

- A $\geq 90$
- B $\geq 80$
- C $\geq 70$
- F $< 70$

Grading will be based on performance on the set of programming assignments, the class final project, paper reviews and design critiques, and class participation, using the following percentage distribution:

- Programming Assignments: 55%
- Final Project: 25%
- Paper Readings: 5%
- Design Critiques: 5%
- Class Participation: 10%

Submission for assignments, final project, reviews, and design critiques will be due on midnight of the due date, a late submission will receive a penalty of 10% per day for each work day it is late.

Programming Assignments  Students will be asked to complete programming assignments using Processing (http://www.processing.org) as well as other software tools. Individual assignments will be put together into a weighted average of the total programming assignment.

Final Project  A final project of the student’s choice may be completed using any of the skills learned in the class. Projects will be proposed midway through the semester and must demonstrate visualization of a data modality of the student’s choice.

Paper Readings  As one of the major goals of this course is to prepare students to be able to read research papers in the field of visualization, one of the main exercises we will do is reading papers relevant to the material discussed in class. Each lecture I will assign both “required” and “recommended” readings for the material covered in class, with the expectation that students will read a subset of this material.

This reading will be rated through online question and answers on our Piazza site. You are responsible for asking questions for a subset of weeks as well as participating in a discussion of a question on the weeks you have not asked a question.

The remainder of the class will be responsible for discussing and providing answers to these questions. Discussions count towards your class participation grade.

Design Critiques  Students will perform one design critique for a visualization of their choice found from popular such as a newspaper, textbook, or magazine. Scientific magazines such as Nature or Science are allowed, but visualization journals and venues, where the topic of the work in question is primarily visualization, is not allowed.

Each week several students will post a design critique on our Piazza site. You are responsible to post one design critique during the semester and to actively participate in a discussion of a critique each week.
**Class Participation**  

The class participation grade is the instructor’s subjective judgement of the student’s contribution to a lively classroom atmosphere. He will consider mainly active, informed participation in classroom discussions, quiz and homework reviews. Obviously, students not attending class are not contributing in this way.

One component of the participation grade will be evaluating the design critiques of others. At the start of each week, design critiques will be analyzed by the class as a whole. Positive feedback and constructive criticism will be provided to the student(s) who completed that week’s critique.
Policies

Late Instructor  Your instructor will make every effort to be in class on time, or to inform you of any delay or cancellation. In the unusual event that he should not arrive in class or send word by 15 minutes from the class start time, the class is officially cancelled.

Attendance  Optional, but note that a percentage of the grade is based on class participation.

Collaboration Yes, Plagiarism No  In this course, we want to encourage collaboration and the free interchange of ideas among students and in particular the discussion of homework and quiz problems, approaches to solving them, etc. However, we do not allow plagiarism, which, as commonly defined, consists of passing off as one’s own ideas, words, writings, etc., which belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism also applies to using work and materials from those outside of the class. The same rules apply whether you are asking a friend, unknown student who is not in the class, or another student in this course.

Unless otherwise instructed, you are expected to work independently on projects and assignments. The instructor may use automated tools to look for similarities in code which could indicate plagiarism. Instances of copying or sharing, or cheating in any way will result in an academic dishonesty charge, which can lead to an F in the course or expulsion from the university. Each student is responsible for protecting his or her files and work from access by others. Work that is essentially the same and submitted without proper attribution is considered to be a violation of academic dishonesty policies by all those submitting the work, regardless of who actually did the work. For this course, it is considered cheating to do any of the following:

- Discuss in detail the code in your program with another person (other than the instructor or the TAs)
- Use code obtained from another student, or any other unauthorized source, either modified or unmodified (each student is responsible for protecting his or her files from access by others)
- Use reengineering tools
- Submit work of others, from the Internet or any other source
- Use unauthorized aids on exercises, quizzes, or exams

Publicly available sources for code or other material, in small amounts, may be freely used if appropriately attributed. A good rule of thumb: when in doubt about whether the use of small snippets of code not your own in a programming assignment is allowed, first ask the instructor or TA.

Copyright  Materials in this course are copyrighted. They are intended for use only by students registered and enrolled in this course and only for instructional activities associated with and for the duration of the course. They may not be retained in another medium or disseminated further. They are provided in compliance with the provisions of the Teach Act. Students should refer to the Use of Copyrighted Materials and “Fair Use Guidelines” policy on the Clemson University website. Additional information is detailed at http://libguides.clemson.edu/copyright/.

Disability Access  It is university policy to provide, on a flexible and individualized basis, reasonable accommodations to students who have disabilities. Students with disabilities requesting
accommodations should make an appointment with Dr. Arlene Stewart (656-6848), Director of Disability Services, to discuss specific needs within the first month of classes. Students should present a Faculty Accommodation Letter from Student Disability Services when they meet with instructors. Accommodations are not retroactive and new Faculty Accommodation Letters must be presented each semester.

Students are encouraged to contact Student Disability Services, Suite 239 in the Academic Success Center, 656-6848, to discuss their individual needs for accommodation. Accommodations are individualized, flexible, and confidential and are based on the nature of the disability and the academic environment, in compliance with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990. Details on policies and procedures are available at http://www.clemson.edu/sds/.

**Title IX (Sexual Harassment)** Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran’s status, genetic information or protected activity (e.g., opposition to prohibited discrimination or participation in any complaint process, etc.) in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972. The policy is located at http://www.clemson.edu/campus-life/campus-services/access/non-discrimination-policy.html and http://www.clemson.edu/campus-life/campus-services/access/title-ix/.

Mr. Jerry Knighton is the Clemson University Title IX Coordinator. He also is the Director of Access and Equity. His office is located at 111 Holtzendorff Hall, and he may be reached at knightl@clemson.edu, 864.656.3181 (voice), or 864.565.0899 (TDD).

**Academic Integrity** As members of the Clemson University community, we have inherited Thomas Green Clemson’s vision of this institution as a “high seminary of learning.” Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form. In instances where academic standards may have been compromised, Clemson University has a responsibility to respond appropriately to charges of violations of academic integrity.

Refer to the Graduate School Policy Handbook for the graduate academic integrity policy at http://www.clemson.edu/graduate/students/policies-procedures/index.html. Each graduate student should read this policy annually to be apprised of this critical information.