Graphics and Data Visualization

CS1501 Fall 2013 Syllabus

Course Description

With the advent of powerful data-mining technologies, engineers in all disciplines are increasingly expected to be conscious of the interaction between massive quantities of information. This multidisciplinary course introduces the practical concepts of graphic design related to data visualization and interactive design through short hands-on projects. This course is specifically designed with engineering majors in mind; it focuses on their knowledge and provides a powerful tool for engineers to use to communicate their studies in technical fields.

Course topics include: cognitive load theory, communication design, identification of "chart junk", graphical integrity, optimization of data-ink in multivariate data sets, infographics, vector graphics, and interactive data visualization using JavaScript.

Course Objectives

By the conclusion of this course students will:

- Understand how to more effectively communicate information using efficient visuals
- Be able to identify and analyze misleading charts and visualizations
- Articulate a practical understanding of symbolism as it applies to cognitive load theory
- Demonstrate familiarity with visual design by developing an interactive data visualization
- Present their skills in visual design and communication in a concluding conference

Prerequisites

No previous knowledge of course material is expected. Prior experience in image editing or object-oriented programming may lead to a more sophisticated final project but is not required.

Course Instructor

Kevin McVey: 4th Year Computer Engineering major with Architecture minor focused on art and visual design. Interests and current fields of study include embedded systems, computer graphics, HCI, and engineering applied to the study and analysis of real-world phenomena.
Email: kmm4ce@virginia.edu

Unresolved issues with the course, grades, or instructor, should be taken to the point of contact.

Point of Contact

Prof. Tom Horton: Associate Professor of Computer Science. Research interests include computer science education, software engineering, text analysis, and humanities computing.
Email: horton.uva@gmail.com

Optional Textbook

The Visual Display of Quantitative Information, 2nd Edition, by Edward R. Tufte
Note: Reading is not required but has been scheduled to enrich the experience for those interested.

Grading

40%: Attendance	Only two class sections may be missed, all others are weighted equally.
30%: Homework	Each homework assignment will be graded by the Instructor and given a score between 1 and 5 based upon the work's reflection of the student's understanding of course material.
30%: Final Project	Students will be required to produce an interactive visualization by the conclusion of the course. On the final class meeting, students will present their projects and will be graded on the quality of their project and their understanding of course material as shown in their presentations.

Students are **not** graded on their artistic ability; previous design experience is **not** required.

Course Schedule

Week 1: Introduction to Visualization

- What is Data Visualization?
- What can engineers learn from graphic designers and why does it matter?
- Examples of bad graphics and good graphics in numerous situations

Homework:

- Install GIMP and get familiar with its GUI, try out the different selection and fill tools following a provided tutorial.

Week 2: Graphical Excellence

- Finding relationships in multivariate datasets
- How 2 and 2 together can tell the story of 5
- Organization and juxtaposition

Homework:

- Search the Internet for two excellent infographics / visualizations and turn them in with a sentence or two **each** about what makes them effective.

Week 3: Data-Ink

- The essential, un-erasable portions of graphics
- Edward Tufte's "Data-Ink Ratio" equation
- Erasure, symmetry, and redundancy

Homework:

- Use GIMP to re-design a provided visual to increase its data-ink ratio.

Week 4: Communication Design

- Affordances
- Symbolism and cultural constraints
- Consistency in design
- Feedback and clarity

Homework:

- Design three pictographs that could be used to explain to someone who does not speak your language how to complete a simple task. These tasks should be basic, such as opening blinds or fluffing a pillow.

Week 5: Chart Junk

- Beautiful design vs. useful design
- Paring down designs to make visuals more efficient
- Cognitive Load theory

Homework:

- Use GIMP to re-design a provided complex visual to make it easier to interpret.

Week 6: Graphical Integrity

- How graphics are used to skew data
- Chart junk and data obfuscation
- Omission, sampling, and graphic bias
- Edward Tufte's "Lie Factor" equation

Homework:

- Try to fool the class! Use a statistic to produce a chart or visual that you believe obfuscates information or even misleads its audience. If possible, calculate your own lie factor.

Week 7: Spatial Arrangement and Graph Evaluation

- Spatial layout and its affect on perception of information
- Edward Tufte's "Data Density" equation
- "Small Multiples"
- Chart evaluation and extraneous cognitive load

Homework:

- Look back on the graphics you chose to review during week 2. Write a short response on whether you still agree with their quality given your current knowledge of data graphics. Is there anything that is particularly effective? Is there anything that you would change?

Week 8: Welcome to Vector Graphics and Raphaël

- Shapes and paths, the vector graphic building blocks
- How to use Raphaël to draw vector graphics to the "Paper"
- Vector graphic attributes

Homework:

- Install Google Chrome and download the Raphaël library. Draw a few basic shapes and then try to write your name as a vector graphic.

Week 9: JavaScript Basics and Raphaël

- Weakly typed variables: "var"
- Prototypes in place of classes
- Functions as first-class objects

Homework:

- Write a function that will draw a box given a size variable. Now write a function that will draw n boxes of a particular size. Give the n boxes one varied attribute such as opacity, color, or line weight.

Week 10: Interactivity and Animation in Raphaël

- How to use Raphaël Element functions that enable interactivity
- Using the Animation class to make vector graphics visually responsive

Homework:

- Using first-class functions make a shape with an attribute that animates when clicked. Now try making a shape disappear and reappear given some sort of input.
- Propose a final project concept for implementation as an interactive data visualization.

Week 11: Moving from Table to Visual

- Modulating vector graphics using actual data
- Automating the process of data dense image generation

Homework:

- Make a series of shapes with an attribute that is dependent upon some data set. Arrange them in some meaningful manner that helps display the data.
- Begin working on Final Project

Week 12: A Short Crash Course in Aesthetics

- Line weight
- Color schemes
- Typography
- Scale and juxtaposition

Homework:

- Continue working on Final Project, be prepared to discuss during next meeting.

Week 13: Final Project Workshop

- Share final project progress and discuss improvements

Homework:

- Continue working on Final Project.

Week 14: Final Project Presentations – Visualization Conference

- Present final projects to peers and guests

No homework

Reading Schedule

Course readings are entirely optional. Those who want a more in-depth look at course topics are encouraged to follow the following reading schedule from the course text:

Week	**Best Paired With Chapter…**
Weeks 1 – 2	1: Graphical Excellence
Weeks 3 – 4	4: Data-Ink and Graphical Redesign
Weeks 5 – 6	5: Chartjunk: Vibrations, Grids, and Ducks
Week 6	2: Graphical Integrity
Week 7	7: Multifunctioning Graphical Elements
Weeks 11 – 12	9: Aesthetics and Technique in Data Graphical Design