USC VITERBI SCHOOL OF ENGINEERING
DATA SCIENCE PROGRAM

DSCI 554: Data Visualization

2:00-3:50pm Monday, Wednesday - WPH B27 (4 Units)

Instructor: Dr. Luciano Nocera   Assistants: TBD
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Office: PHE 335

Instructor's Office Hours: 02:00pm-04:00pm Tuesday. Other hours by appointment only. Students are advised to make appointments ahead of time in any event and be specific with the subject matter to be discussed. Students should also be prepared for their appointment by bringing all applicable materials and information.

Catalogue Description

Graphical depictions of data for communication, analysis, and decision support. Cognitive processing and perception of visual data and visualizations. Designing effective visualizations. Implementing interactive visualizations.

Course Objective

Visualizations are graphical depictions of data that help people communicate, understand and make decisions. In this course, students will learn the theory and practice of creating data visualizations. In the theory part students will learn how our brains process visual data, and how the way our brains work affects how we perceive visualizations and how we should design visualizations to make them easy to understand. Students will get an understanding of which colors and shapes stand out clearly, how to organize visualizations and when images convey ideas more clearly than words. In the practical part of the course students will learn guidelines and methods to design effective visualizations and how to implement interactive visualizations in the Web and and in notebooks using a variety of modern visualization libraries and tools.

Class Communication

Blackboard at USC will be used for class communication and online collaboration tools will be leveraged to facilitate the homework and the projects.

Books and Readings

All books, papers or reports will be available to students online, at the USC bookstore and/or via the USC libraries at http://www.usc.edu/libraries/.

Required Readings

Visual Thinking for Design, by Colin Ware. ISBN: 978-0123750303.

The Functional Art: An Introduction to Information Graphics and Visualization, by Alberto Cairo. ISBN: 978-0321834737.

Murray, Scott. Interactive Data Visualization for the Web: An Introduction to Designing with D3. O'Reilly Media, Inc., 2017.

Optional Readings

Envisioning Information, by Edward R. Tufte. ISBN: 978-0961392116.

Cairo, Alberto. The truthful art: data, charts, and maps for communication. New Riders, 2016.

Grading Schema

Quizzes:	20%
Homework Assignments:	30%
Class Project:	30%
Final:	20%
Total	100%

Grades will range from A through F. The following is the breakdown for grading:

94 - 100 = A	74 - 76 = C
90 - 93 = A -	70 - 73 = C-
87 - 89 = B+	67 - 69 = D+
84 - 86 = B	64 - 66 = D
80 - 83 = B-	60 - 63 = D-
77 - 79 = C+	Below 60 is an F

The graded coursework will consist of four major components:

Quizzes

There will be a quiz most weeks. The quiz will include 10 questions testing understanding of the material from the previous week and questions about the readings for the class. The questions are suitable for students who read the required readings. The worst quiz score will not count

towards the grade. There will be no make-ups or rescheduling for any reason (this is why one quiz does not count).

Homework Assignments

Homework will be assigned weekly. Homeworks will require up to 4 hours to complete. Each student is expected to submit the completed assignment each week. Homeworks are submitted individually and students will receive individual scores. Students may work in groups to complete the homeworks however it is expected that coding is done independently by each student. For the last four weeks of the course there will be no homeworks as students are expected to work on the class projects exclusively. Students are expected to arrive in class each week having completed the assignments for the period, and be prepared to engage in informed discussions on those materials.

Final Exam

in person, close book

The final exam is cumulative, and will be done on the day that USC schedules it. Students should look at the schedule of finals before planning their vacations, as there is no option for rescheduling.

Class Project

The class project gives students the opportunity to put into practice the theory and techniques covered in class. The projects are about designing and implementing a dashboard or an interactive infographic. The project is a group project of three-four students. An important objective of the class is to teach students to work in groups, so students cannot work on projects individually. Project deliverables will consist of the following 4 items:

1. Demo: students should produce a working demonstration of the system and deploy it.

2. Video: students should produce a 5-minute (or less) video of their application and upload it to YouTube.

3. Paper: students should write a final paper about the project as if they were submitting it to a conference for publication. The papers should be written in the LNCS format (Springer LNCS guidelines, Overleaf LNCS template) and should be at most 5 pages long. The paper should be organized as a publication, stating the problem being addressed, the approach and description of the system, evaluation, related work and references.

4. Presentation: students will present their projects to the class using the PechaKucha presentation format (see http://www.pechakucha.org). PechaKucha is a simple presentation format where you show 20 images, each for 20 seconds. Depending on class size we may need to adjust the number of images allowed. The images advance automatically and you talk along. You cannot use bullets in any of your slides.

Statement for Students with Disabilities

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m. - 5:00 p.m., Monday through Friday. Website and contact information for DSP: http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html, (213) 740-0776 (Phone), (213) 740-6948 (TDD only), (213) 740-8216 (FAX) ability@usc.edu.

Statement on Academic Integrity

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. SCampus, the Student Guidebook, (http://www.usc.edu/scampus or http://scampus.usc.edu) contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A.

Emergency Preparedness/Course Continuity in a Crisis

In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies.

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism - presenting someone else's ideas as your own, either verbatim or recast in your own words - is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Section 11, Behavior Violating University Standards. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct. Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the Office of Equity and Diversity http://equity.usc.edu/ or to the Department of Public Safety. This is important for the safety whole USC community. Another member of the university community - such as a friend, classmate, advisor, or faculty member - can help initiate the report, or can initiate the report on behalf of another person. The Center for Women and Men provides 24/7 confidential support, and the sexual assault resource center webpage sarc@usc.edu describes reporting options and other resources.

Support Systems

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the American Language Institute, which sponsors courses and workshops specifically for international graduate students. The Office of Disability Services and Programs provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, USC Emergency Information will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.

Statement on Diversity

The diversity of the participants in this course is a valuable source of ideas, problem solving strategies, and engineering creativity. I encourage and support the efforts of all of our students to contribute freely and enthusiastically. We are members of an academic community where it is our shared responsibility to cultivate a climate where all students and individuals are valued and where both they and their ideas are treated with respect, regardless of their differences, visible or invisible.

Schedule

The schedule is tentative and subject to change.

Week	Topic	Readings	Homework	Exam
Week 1 Aug. 22 Aug. 24	Introduction to data visualization; why it is important, what are it's uses, course overview, overview of developing visualisations in the browser. Lab on basics of javascript, frameworks and node.js.	Murray Ch. 1,2 Cairo I, Ch. 1,2	Assignment 1. Follow Cairo Part I, Ch.1 example on UN Data. For 10 countries select UN data of your choice containing data over time. Import the data in Google Sheets and format the data to create a line chart, export the chart to a web page.	
Week 2 Aug. 29 Aug. 31	Survey of visualization techniques; introduction to Web Technologies.	Murray Ch. 3,4 A Tour through the Visualization Zoo, J. Heer, M. Bostock, V. Ogievetsky. Communications of the ACM, Jun 2010. Google charts manual	Assignment 2. Use UN Data for the same 10 countries of Assignment 1 to create a bubble cloud with Inkscape. Create a web page named index.html and add the SVG created with Inkscape. In the same page, recreate the bubble cloud with SVG elements and using javascript. Add the line chart of Assignment 1 coded using the Google Charts library.	Quiz 1
Week 3 Sep. 7	Nomenclature of popular visualization tools; design space of visualizations; the visualization wheel; design trade-offs; developing interactive graphics; introduction to D3. Lab on debugging in the browser.	Cairo I, Ch. 3 Murray Ch. 4,5	Assignment 3. Critiquing visualizations in news media. Find 2 different infographics on the same subject and compare them using the visualization wheel. What do they do well, what do they do poorly? Suggest improvements for the things they do poorly. Document in HTML.	Quiz 2

Week	Topic	Readings	Homework	Exam
Week 4 Sep. 12 Sep. 14	Balancing function and esthetics; minimalism; making visualizations memorable; designing dashboards; D3 drawing with DIV and SVG; Styling graphic elements; creating basic plots.	Cairo I, Ch. 4 Murray Ch. 6	Assignment 4. From World Bank Open Data download Rural population (% of total population) for 20 countries and a year of your choice. In an HTML document, load the data as CSV using D3. With D3, using data joins, create an HTML table, and SVG bar chart, scatterplot, and bubble chart. Publish on your USC SCF account.	Quiz 3
Week 5 Sep. 19 Sep. 21	The eye and the visual brain; visual queries; implications for design; scales; using scales in scatter plot and bar charts; using scales with axes; rendering axes.	Ware Ch. 1 Cairo II, Ch. 5 Murray Ch. 7,8	Assignment 5. Using the data of Assignment 4, load the data in JSON format, then using D3 data joins, present the data in as SVG table, scatterplot, bar chart and slope graph. All plots should use D3 scales and include axes, axes labels, tick marks, and tick mark labels as applicable. Publish on USC SCF account.	Quiz 4
Week 6 Sep. 26 Sep. 28	Project proposals discussion and prep for final presentations. Lab on frameworks, responsive visualizations.	Murray Ch. 7,8	Assignment 6. Implement a basic dashboard with Vue.js and Bootstrap, building and deploying a custom dashboard, implement various examples of responsive visualizations.	

Week	Topic	Readings	Homework	Exam
Week 7 Oct. 3 Oct. 5	Preattentive features. Updating D3 visualizations; changing data and updating the visuals; smooth transitions and animations. Updating the axes; adding and removing data values.	Ware Ch. 2 Cairo II, Ch. 6 Murray Ch. 9,10,12 Healey and James, Attention and visual memory in visualization and computer graphics, IEEE Transactions on Visualization and Computer Graphics, 2012.	Assignment 7. Select 1 year from the dataset you created for Assignment 1. Load the data in JSON and implement a D3 bar chart complete with axes, tick marks and labels. Implement smooth transitions based on user input to reorder the bars: show all bars in alphabetic order (default), ascending order, descending order, top 5, bottom 5. Update the axes and legend as needed.	Quiz 5
Week 8 Oct. 10 Oct. 12	Colors and color vision; trichromatic theory; opponent process theory; color channels; color coding information. Color models. Emphasis and highlighting; color sequences, semantics of color. D3 color generators; D3 layouts.	Ware Ch. 4 Murray Ch. 11,13 Cairo IV Profile 1-5	Assignment 8. Use data from one of your assignments and implement three layouts of your choice using D3.	Quiz 6
Week 9 Oct. 17 Oct. 19	Depth perception and cue theory: different ways to perceive depth. 2.5D design; showing data in maps; map layers; map projections; working with geospatial data.	Ware Ch. 5 Murray Ch. 14,15 Cairo IV Profile 6-10	Assignment 9. Use data from Assignment 1 (one year 10 countries) to build a proportional symbol map and a choropleth map with D3.	Quiz 7
Week 10 Oct. 24 Oct. 26	Statistics and statistical graphics. Python and R basics and major graphing libraries, notebooks. Part I.	Wickham, Hadley. "ggplot2." Wiley Interdisciplinary Reviews: Computational Statistics, 2011.	Work on Project Assignment 10. Part 1. Use Tableau, Python and R notebooks, to visualize (a subset of) your project data.	Quiz 8
Week 11 Oct. 31 Nov. 2	Python and R basics and major graphing libraries, notebooks. Part II.	Murray Ch. 16 Walk-Through & A. Case Cairo III, Ch. 8,9	Assignment 10. Part 2. Use Tableau, Python and R notebooks, to visualize (a subset of) your project data.	

Week	Topic	Readings	Homework	Exam
Week 12 Nov. 7 Nov. 9	Linking perception and action; the *where* pathway in our brains; how the brain recognizes objects; the pattern-processing machinery; visual memory and attention; feature encoding; Gestalt theory; semiololgy. Introduction to 3D visualizations and tools.	Ware Ch. 3 Cairo II, Ch. 7 Cairo IV, Profiles	Work on Project.	Quiz 9
Week 13 Nov. 14 Nov. 16	Course review. Lab on projects.	Ware Ch. 6,7 Cairo IV, Profiles	Work on Project.	Quiz 10
Week 14 Nov. 21	Lab on projects.		Work on Project.	
Week 15 Nov. 28 Dec. 30	Lab on projects. Project Presentations.		Work on Project.	
Dec. 9	Final examination per University schedule – Friday, December 9, 2-4 p.m.			