Master of Business Analytics

Data Visualization Fall 2019 Syllabus

Course Information

Instructor Information

Instructor: Nicholas Rabinowitz
Office Hours: Fridays 4-5 pm or by appointment
E-mail: nickr@uber.com

Course Description

Course topics include an overview of vocabulary, theory and principles as well as the algorithms and methods for structured and unstructured data visualization. The course will teach students how to present information in an understandable and efficient way for the purposes of data analysis and effective communication of results. The course also empowers students to critically analyze good and bad visualizations, and develop ways to improve on them.

Prerequisite
Basic programming / Python preferred

Textbook & Course Materials

Required Texts

- The Visual Display of Quantitative Information, 2nd Ed, Edward R Tufte
- Now You See It, Stephen Few

Optional Texts

- Information Visualization, Perception for Design, Colin Ware
- Visualizing Data, Ben Fry
- The Functional Art, Alberto Cairo
- How Maps Work, Alan M. MacEachren

Course Software Requirements

The course will explore a range of visualization tools, including applications like Tableau and Kepler.gl as well as Jupyter notebooks and Python-based visualization libraries. All required software will be available free of charge.

Course Structure

This course will be interactive and focused on hands-on experience. Each session will have both a theory lecture led by the instructor or guest lecturers, and a practical session consisting of coding-based workshops, discussions, student presentations, etc. Each course session will emphasize a key topic in data visualization.

Student Responsibilities

- Please attend every class. A portion of your grade will be based on class participation and in-class projects.
- Classes will start promptly at the hour. Please arrive on time.
- Class assignments are expected to be completed by 5pm on the day they are due. Late assignments may be marked down.
- It is expected that all class members will treat each other with respect and dignity, both in class interactions and in group projects.

We are committed to the promotion of absolute integrity and high ethical standards in academic work. More information about Code of Academic Conduct can be found at the Code's webpage (http://sja.ucdavis.edu/files/cac.pdf).

Part 2: Student Learning Outcomes

Data visualization is a particularly broad field of study, with research areas ranging from computer science to human-computer interaction to visual design. The goal of this course is to offer students a solid foundation in visualization theory and principles, and then help them apply this knowledge in weekly projects and workshops aimed at developing their skills in creating and evaluating data visualizations. Sessions will cover major areas of visualization including studies of visual perception; time-based, categorical, and geospatial analysis; graphs and networks; and visual storytelling, as well as the practical creation of visualizations using tools including Python and Tableau.

Learning objectives:

- Understand basic principles of data visualization
- Evaluate and think critically about data visualization examples
- Create effective visualizations for data analysis and presentation using a range of tools

Part 3: Topic Outline/Schedule

Module 1: 9/27
Topic: Introduction to Data Visualization
Reading:

- The Visual Display of Quantitative Information, Edward Tufte, Chapter 1: Graphical Excellence
- Perception in Visualization, Christopher Healy
- A Tour Through the Visualization Zoo, Jeffrey Heer, Michael Bostock, and Vadim Ogievetsky
- *(Optional)* Information Visualization, Perception for Design, Colin Ware, Chapter 1

Lecture: We'll cover principles of data visualization, including how to model human perception in information visualization research, mapping from data types to visual marks and channels, and a taxonomy of visualizations, laying out the fundamentals for the rest of the course.
Workshop: *Evaluating data visualizations*

Module 2: 10/4
Topic: Elements of Data Visualization
Reading:

- The Visual Display of Quantitative Information, Edward Tufte: Chapter 2: Graphical Integrity
- The Visual Display of Quantitative Information, Edward Tufte: Chapter 4: Data-Ink
- Visualizing Data, Ben Fry: Chapter 1
- *(Optional)* How NOT to Lie with Visualization, Rogowitz & Treinish, 1996

Lecture: We will review the elements that make up data visualizations, including marks, scales, color, legends, labels, and interactivity. We will also explore the data visualization process and workflow, from acquiring data to building and presenting visualization interfaces.
Workshop: *Intro to data visualization in Jupyter notebooks*

Module 3: 10/12
Topic: Hierarchies, Graphs, and Networks (Guest lecturer: Yang Wang)
Reading:

- treevis.net - A Visual Bibliography of Tree Visualization
- A Study of Layout, Rendering, and Interaction Methods for Immersive Graph Visualization [video]
- *(Optional)* Graph Visualization and Navigation in Information Visualization: A Survey

Lecture: We will cover the fundamental concepts of working with hierarchical and graph data, including data structures, different visual metaphors to represent hierarchies, the connection between tree and graph visualizations, popular layout algorithms, and recent applications. We will also study the principles of making effective graph visualizations with consideration of visual design and cognitive science.
Workshop: *Creating graph visualizations*

Module 5: 10/25
Topic: Visualization for Business Intelligence
Reading:

- Now You See It, Stephen Few, Chapter 4: Analytical Interaction and Navigation
- Now You See It, Stephen Few, Chapter 5: Analytical Techniques and Practices

Lecture: We will cover the concept of dashboard, a set of interconnected charts organized to support a specific task. We'll look at the types of questions that business intelligence tools answer, the building blocks of dashboards, and the relationships between different components in a business intelligence application.
Workshop: *Introduction to Tableau*

Module 4: 10/18
Topic: Temporal Data Visualization
Reading:

- Now You See It, Stephen Few, Chapter 7: Time Series Analysis
- Now You See It, Stephen Few, Chapters 9: Deviation Analysis

Lecture: We'll look at the many ways to represent time in visualizations, plotting time on different axes, working with seasonal data, filtering/brushing, temporal annotations, animation, timelines, progressively working our way towards more advanced techniques such as small multiples and connected scatterplots.
Workshop: *Creating time series visualizations*

Module 6: 11/1
Topic: Storytelling with Data (Guest lecturer: Chris Gervang)
Reading:

- Narrative Visualization: Telling Stories with Data, Segel & Heer 2010
- NPR Guide to Hypothesis-Driven Design

Lecture: We will cover the general principles of storytelling with data: exploration vs explanation, understanding the audience, mechanisms of attention and engagement. We'll present various narrative patterns for different purposes and explore successful examples.
Workshop: *Storyboarding with data*

Module 7: 11/8
Topic: Geospatial Visualization (Guest lecturer: Shan He)
Reading:

- How Maps Work: Representation, Visualization, and Design, Alan M. MacEachren
    - Chapter 1: How meaning is derived from maps
    - Chapter 2. How maps are imbued with meaning
- *(Optional)* How to Lie with Maps, Mark Monmonier, Chapter 2: Elements of the Map

Lecture: We will take a look at the theory and practice of visualizing geospatial data with maps. Starting by discussing the theory behind how we understand maps, we will review several common types of mapping visualizations.
Workshop: *Introduction to Kepler.gl*

Module 8: 11/15
Topic: Visualization for Data Science (Guest lecturer: Lezhi Li)
Reading:

- Machine Learning for Hackers, John Myles White & Drew Conway: Chapter 2: Data Exploration
- Now You See It, Stephen Few, Chapter 10: Distribution Analysis
- Now You See It, Stephen Few, Chapter 11: Correlation Analysis

Theory lecture: The theory class will cover techniques for using visualization to facilitate statistical analysis and solve data science problems. We will introduce several archetypical charts often used in visual analytics, and how to choose between them based on the dataset in question (univariate, bivariate, trivariate, multi-dimensional data). We will also look at examples of advanced usage of these archetypes and real-word applications.
Practical Lecture: *Using visualization in the data science workflow*

Module 9: 11/22
Topic: New mediums for visualization (Guest lecturers: Ramik Sadana, Taeheon Kim)
Lecture: In this module, we will go beyond mouse, keyboard and 2D screens, and examine what new forms of computing devices, such as touch, speech, AR and VR, have in store for data visualizations. We will explore the opportunities and challenges of each of these new platforms, identify the new product opportunities they open up, and discuss the latest research in these areas.

Module 10: 12/6
Topic: Visualization in Industry / Wrap Up
Lecture: We will discuss lessons from visualization work in industry, including use cases for visualization, building and buying visualization applications, incorporating visualization into products, and approaches to mainstreaming visualization as a tool

within your organization. This session will also present a brief wrap up of the course.

Final Assignment Due: 12/13, 5:00pm
There is no class on 12/13, and no final exam.

Grading

1. Class participation: 15%
2. Individual and group assignments: 60%
3. Final project: 25%