

Statistical Visualization II —

Stat 5560, Section 001 & Stat 6560, Section 001

Spring 2020 (2 Credits)

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Office Hours: Tuesday (T) 10:00am – 11:00am, Thursday (H) 4:30pm – 5:30pm, and by appointment. I may also be available Thursday (H) 3:30pm – 4:30pm.

Classes & Rooms:

TH 12:00noon – 1:15pm, T 1/21/20 – H 4/9/20 or H 4/16/20 (tentatively): AnSc 320.

Please visit the course Web page listed above and/or Canvas frequently for lecture notes, recordings of lectures, data sets, graphical examples, R code, etc. — in particular if you miss class for any reason.

Detailed Class Schedule:

For a 2-credit course, we need 20 lectures/lecture days (in contrast to 29 or 30 lectures/lecture days for a 3-credit course). Those days are marked as “Lecture 01” to “Lecture 20” in the overview below:

Week	Tuesday	Thursday
1	1/7: No class	1/9: No class
2	1/14: No class	1/16: No class
3	1/21: Lecture 01	1/23: Lecture 02
4	1/28: Lecture 03	1/30: Lecture 04
5	2/4: Maybe	2/6: Maybe
6	2/11: Lecture 05	2/13: Lecture 06
7	2/18: Lecture 07	2/20: Lecture 08
8	2/25: Lecture 09	2/27: Lecture 10
9	3/3: No class	3/5: No class
10	3/10: No class	3/12: No class
11	3/17: Lecture 11	3/19: Lecture 12
12	3/24: Lecture 13	3/26: Lecture 14
13	3/31: Lecture 15	4/2: Lecture 16
14	4/7: Lecture 17	4/9: Lecture 18
15	4/14: Lecture 19/Backup	4/16: Lecture 20/Backup
16	4/21: Backup	

Note: “No class” means guaranteed no class that day. I have marked a few days as “Backup”, e.g., in case we miss lectures because of snow days, I am sick, or I have to travel. But, hopefully,

this won't happen. If nothing goes wrong, our tentative last lecture date will be on H 4/9/20 or H 4/16/20, depending on whether I will have to travel on T 2/4/20 and H 2/6/20.

Course Objectives:

Statistical graphics and data visualization are critical elements of modern data analysis and presentation. From initial exploration of a data set to the final presentation of results to the end user, statistical graphics play a vital role in shaping our understanding of our data. Through proper use of graphics, we can make critical discoveries, and communicate them clearly. Conversely, poor use or misuse of graphics can seriously mislead (by accident or design).

The course will address three main questions:

1. Why statistical graphics (and which ones to draw)?
2. How to construct statistical graphics in R?
3. How to distinguish between **good** and **bad** statistical graphics?

This course is **not** an introduction into a single R graphics package. Rather, a variety of R graphics packages will be used, such as `baseR`, `ggplot2`, `lattice`, etc.

Even more than most aspects of statistics, graphics and visualization involve art as well as science. In most cases, there are many reasonable approaches. Only an understanding of the options available and the underlying principles will lead to a successful analysis and presentation.

Prerequisites:

I expect basic knowledge of R as taught in the “Introduction to R” course. More importantly, I expect that you previously took my “Statistical Visualization I” course or have equivalent knowledge. Moreover, you should be familiar with a tool such as R Markdown, knitr, or sweave that allows you to combine text, R code, graphics, and numerical results in high-quality documents. \LaTeX is a plus but is not formally required at the 5000 level, but it will be required at the 6000 level of this course.

Moreover, I expect basic “operational” knowledge from an introductory stats course such as Stat 2000, Stat 3000, or higher. “Operational” means that you still recall sufficient details from regression, ANOVA, hypothesis tests, etc. (it is not sufficient that you have taken such a course several years ago and have forgotten almost all details).

IDEA Center Learning Objectives:

Objective 1) Gaining factual knowledge (terminology, classifications, methods, trends).

Objective 2) Learning fundamental principles, generalizations, or theories.

Objective 3) Learning to apply course material (to improve thinking, problem solving, and decisions).

Topics: (subject to change)

This course will continue where “Statistical Visualization I” ended:

1. Statistical Maps.
2. Color and Cognition.
3. Graphs for Bivariate Data.
4. Graphs for Trivariate Data.

5. Graphs for “Hypervariate” (High-Dimensional) Data.
6. Interactive and Dynamic Graphics.
7. Web-Based Graphics.
8. History of Graphics.
9. Others (as time permits).

We will work with some data sets suitable for particular concepts introduced in class. These data sets will contain surprises — for you and for me. Do not expect that someone is going to give you the final answer or model. We jointly will have to work towards such an answer or model.

For MS and PhD students majoring in Statistics, it is important to learn L^AT_EX — from basic document preparation, over the inclusion of R graphics into your L^AT_EX documents to advanced topics such as Sweave (<https://leisch.userweb.mwn.de/Sweave/>) and the L^AT_EX bibliography BibTeX (<http://www.bibtex.org/>). L^AT_EX is essential for graduate work (at the MS and PhD level) and will be used for many theses, dissertations, and scientific publications. Therefore, L^AT_EX will have to be used for all homeworks, projects, presentations, etc. at the 6000 level of this course.

Homework Assignments:

There will be a variety of assignments throughout the semester. Each assignment will include a value (typically 20–100 points) that it will be scored out of. Your final grade will be determined by the sum of your points in all assignments. Some assignments will include combinations of analysis of existing graphics, creation of your own, computer work in R (or others), and short oral presentations. The value of each assignment will be roughly proportional to its importance and the amount of work involved.

Regular homework assignments will be done individually or in groups of 2 or 3 students. For individual assignments, you will be allowed to discuss general approaches to questions on the assignments with other students, but each student must write and submit their own code and comments. Any students caught sharing code will fail the class.

Unless otherwise stated on the assignment sheet, all homework assignments have to be submitted electronically via Canvas. **You will have 1 or 2 weeks after the last lecture to finalize and submit the last homework assignment.**

The following deductions will be applied to late homework submissions: 1 min – 24 hours late: 10% off; > 24 hours – 48 hours late: 25% off; > 48 hours – 72 hours late: 50% off. Homeworks won’t be accepted later than 72 hours (i.e., 3 days) after the submission deadline.

There will be no (in-class or take-home) quizzes, midterm exams, or final exams. Nevertheless, this will be a very challenging course that requires a lot of individual time to work on the assignments (and projects). Just attending classes will not be enough to pass this course! In addition, you will have to do a lot of individual reading of textbooks, online documentation, and help pages, and search for available information on the web.

Projects (Stat 6910 only):

There will be one or two projects during the semester. This could be the presentation of an R package, a summary of a journal paper (related to graphics), an extended open-ended analysis of a data set with a focus on graphics, etc. Projects will require the preparation of

a final project report and possibly a short presentation of your work for the other students in this course. The projects will account for about 30% of your final grade.

Textbooks:

Carr, Daniel B., and Pickle, Linda W. (2010) *Visualizing Data Patterns with Micromaps*, Boca Raton, Florida: Chapman & Hall/CRC Press,
<https://www.crcpress.com/Visualizing-Data-Patterns-with-Micromaps/Carr-Pickle/p/book/9781420075731> & <http://mason.gmu.edu/~dcarr/Micromaps/>.

Tufte, Edward R. (1983) *The Visual Display of Quantitative Information*, Cheshire, CT: Graphics Press.

Unwin, Antony (2015) *Graphical Data Analysis with R*, Boca Raton, FL: CRC Press/Taylor & Francis.

Wickham, Hadley (2009) *ggplot2 — Elegant Graphics for Data Analysis*, New York, NY: Springer,
<http://www.springer.com/us/book/9783319242750>, <https://ggplot2.tidyverse.org/>,
and <https://ggplot2.tidyverse.org/reference/>.

Every student should have access to each of these books, but it is not necessary that every student buys all of these books. Perhaps you can make arrangements with some of the other students in class who purchases which book(s). If you plan to work in the area of statistical visualization for your MS or PhD degree, you should consider to purchase these books for an ongoing use beyond this course.

Software:

We will primarily be using R (<http://cran.r-project.org/>), a free software environment for statistical computing and graphics. Please install a recent version of R, i.e., 3.6.1 or 3.6.2, on your own computer so we can exchange code. Also install RStudio (<https://www.rstudio.com/>) as a front end to R and MiKTeX (<https://miktex.org/>) that will allow us to combine code and results from R into text documents.

Courtesy:

Please turn off cell phones and similar devices before class, and please keep conversations to a minimum during lectures. Please do not read/reply to your e-mails or browse other web pages than the ones discussed during class.

I will not keep track if you come to class or not. However, I would highly recommend to attend all lectures. If you have to miss a lecture, there will be a recording of the lecture available in Canvas (if the technology doesn't fail).

Americans with Disabilities Act:

If a student has a disability that will likely require some accommodation by the instructor, the student must contact the instructor and document the disability through the Disability Resource Center (DRC), during the first week of the course. Any requests for special considerations relating to attendance, pedagogy, taking of examination, etc. must be discussed with and approved by the instructor. In cooperation with the DRC, course materials can be provided in alternative formats — large print, audio, or Braille.

Note:

The above schedule and procedures in this course are subject to change in the event of extenuating circumstances.