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**STAT 679: Statistical Data Visualization**

**3 Credits**

**Course Designations and Attributes**

Natural Science

LAS Credit

Intermediate

**Course Description**

Techniques for visualization within data science workflows. Topics include principles for design of static and interactive visualization and application to spatial, temporal, network, hierarchical, high-dimensional, text, and uncertainty data visualization.

**Requisites**

Graduate/professional standing, member of Statistics Visiting International Scholars program

**Meeting Time and Location**

Monday/Wednesday 11am – 12:15pm, Service Memorial Institute 133

**Instructional Modality**

In-person

**How Credit Hours are Met by the Course**  
The credit standard for this course is met by an expectation of a total of 135 hours of student engagement

with the courses learning activities (45 hours per credit), which include regularly scheduled: readings,

recorded lectures, in-class exercises, one midterm exam, problem sets, and a group project, as described in this syllabus.

**Regular and Substantive Student-Instructor Interaction**

Participation in regularly scheduled lectures each week will include the opportunity for direct interaction between students and the instructor. The instructor will also frequently interact and post announcements in Canvas and email students about academic aspects of the class.

Instructors & Teaching Assistants

**Instructor**

Kris Sankaran ([ksankaran@wisc.edu](mailto:ksankaran@wisc.edu))

~~In-person and virtual office hours will be arranged following the results of~~ [~~this poll~~](https://www.when2meet.com/?16334941-sIMyb)~~.~~

Based on poll results, office hours will be held Tuesdays 2 – 3pm and Fridays 11 – 12pm. They will be hybrid – you can join at Medical Sciences Center 7225C or on [Zoom](https://uwmadison.zoom.us/j/8622164885) [ID: 862 216 4885, passcode: 298858].

Aside: What are possible reasons to attend office hours?

* Discuss concepts and questions appearing in the readings or exercises.
* Discuss your team’s project – brainstorming ideas, evaluating designs, finding references.
* Find resources related to visualization topics of particular interest.
* You would like to introduce yourself.

You do not have to prepare a specific agenda to attend office hours. You are welcome to just visit.

Course Learning Outcomes

1. Draw from a catalog of visual encodings to support specific visual comparisons in temporal, geospatial, network, hierarchical, high-dimensional count, text, and uncertain data and demonstrate facility implementing them using the R and javascript programming languages.
2. Draw from a catalog of interactivity patterns to compose visualizations that respond to user’s dynamic queries.
3. Using the vocabulary of data visualization, analyze and critique visual designs.
4. Given a data analysis problem and initial design solution, iteratively refine visual encodings and interactivity idioms from across the design space until a satisfactory solution is discovered.
5. Navigate the data visualization research literature, summarize the contributions of a specific methodological proposal, and evaluate their applicability in specific problem contexts.

**Grading**

In-Class Exercises: 20%

Midterm: 20%

Problem Sets: 35%

Group Project: 25%

Grades will be assigned according to the percentage scale, A = 92-100, AB = 88-91.9, B = 82-87.9, BC = 78-81.9, C = 70-77.9, D = 60-69.9, F = 0-59.9 (92% of points => A); and according to the percentile scale, A = 75, AB = 65, B = 45, BC = 30, C = 10, D = 5, F = 0 (performing better than 75% of the class => A). Your grade will be the higher of these two grades.

Course Website, Learning Management System & Digital Instructional Tools

<https://canvas.wisc.edu/courses/321152>

<https://piazza.com/wisc/fall2022/stat679f22/home> (sign-up [link](http://piazza.com/wisc/fall2022/stat679f22))

Required Textbook, Software & Other Course Materials

* There are no required textbooks. All readings are provided in the table below.
* This course is taught using the R and javascript programming languages. We expect prior experience with the R language, but javascript will be taught from the basics. Relevant resources for becoming familiar with the tools we will use are,
  + [The R Project for Statistical Computing](https://www.r-project.org/)
  + [ggplot2 documentation](https://ggplot2.tidyverse.org/reference/)
  + [shiny documentation](https://shiny.rstudio.com/)
  + [D3 documentation](https://d3js.org/)

Campus provides students with [technology guidelines and recommendations](https://it.wisc.edu/learn/guides/learning-online-technology-tips-tools/) for instruction. Students should consult these resources prior to the start of the semester.

Homework & Other Assignments

* In-Class Exercises
  + This class follows a partially flipped format. Instructions for in-class exercises and discussions will be posted on Canvas and introduced during class. Deadlines will be specified in the assignment description; with some exceptions, they will be due at the start of the next class session.
  + In-class exercises will be graded for completeness with values in {0%, 50%, 100%}, reflecting the effort demonstrated in the submission.
* Problem sets
  + Problem sets will be due every three weeks. These will include a mix of coding, design, and reflection exercises. Their deadlines are **September 30**, **October 21**, **November 11**, and **December 2**.
* Both in-class exercises and problem sets must be submitted on Canvas.
  + Your three lowest in-class exercise scores will be dropped.
  + For every 24 hours late that a submission is made, it will be penalized 5%, for up to 4 days, after which no submissions will be accepted. The only exception for late acceptance will be in documented medical or family emergencies.
* For help on problems after initial attempts, students are encouraged to ask the instructor or TA during office hours or on [Piazza](https://piazza.com/wisc/fall2022/stat679f22/home), so that all students can benefit equally from discussion.

Exams, Quizzes, Papers & Other Major Graded Work

* One midterm exam will take place in class on **October 24**. If you have exceptional circumstances which require a different exam date, please reach out to the teaching team as soon as possible.
* There will be a group final project. Students will work in teams of 4 - 5 people. Guiding project milestones will be due on **September 19**, **October 14**, **November 18**, and **December 14**. We will have in-class lightning talks on **December 12**.
* There is no final exam.
* No late submissions will be accepted for the group projects.
* Each student will rate their project team members. If a student has two or more peer-ratings below 75%, they will be penalized 25%. If below 50%, the penalty is increased to 50%.

*Guided notes for all readings can be found at this* [*link*](https://krisrs1128.github.io/stat679_notes/) *and on* [*Canvas*](https://canvas.wisc.edu/courses/321152)*.*

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| **Week** | **Module** | **Reading** |
| September 12 | [A1: Visualization with R](https://canvas.wisc.edu/courses/321152/modules/688542) | 1. [Fundamentals of Data Visualization: Chapters 2](https://clauswilke.com/dataviz/aesthetic-mapping.html) 2. [Fundamentals of Data Visualization: Section 21.1](https://clauswilke.com/dataviz/multi-panel-figures.html) 3. [R for Data Science](https://r4ds.had.co.nz/data-visualisation.html): Sections 3.1 - 3.5 |
| September 19 | A1: Visualization with R | 1. [Mastering Shiny: Chapters 3, 4](https://mastering-shiny.org/basic-reactivity.html) |
| September 26 | [A1: Visualization with R](https://canvas.wisc.edu/courses/321152/modules/688542) | 1. [Mastering Shiny: Chapter 7](https://mastering-shiny.org/action-graphics.html) 2. [Visualization Analysis and Design: Sections 12.1 - 12.3, 13.1 - 13.3](https://search.library.wisc.edu/catalog/9911196629502121) 3. Optional:  [Up and Down the Ladder of Abstraction](http://worrydream.com/LadderOfAbstraction/) |
| October 3 | [A2: Visualization with D3](https://canvas.wisc.edu/courses/321152/modules/688543) | 1. [D3 for R Users: Chapters 2, 3, and 5](https://jtr13.github.io/d3book/web.html) |
| October 10 | [A2: Visualization with D3](https://canvas.wisc.edu/courses/321152/modules/688543) | 1. [D3 for R Users: Chapters 4 and 6](https://jtr13.github.io/d3book/update-enter-and-exit.html) |
| October 17 | [A2: Visualization with D3](https://canvas.wisc.edu/courses/321152/modules/688543) | 1. [D3 for R Users: Chapters 7 and 8](https://jtr13.github.io/d3book/interactivity.html) |
| October 24 | [B1: Spatial and Temporal Data](https://canvas.wisc.edu/courses/321152/modules/688544) | 1. [Geographic Data in R: Sections 9.1 - 9.4](https://geocompr.robinlovelace.net/adv-map.html) 2. [Visualization of Time Oriented Data](https://drive.google.com/file/d/1Rlf3Zj5gTxRQq55xMPqE9GqpVLTyfA4b/view?usp=sharing): Section 4.2 |
| October 31 | [B1: Spatial and Temporal Data](https://canvas.wisc.edu/courses/321152/modules/688544) | 1. [Visualization of Time Oriented Data](https://drive.google.com/file/d/1Rlf3Zj5gTxRQq55xMPqE9GqpVLTyfA4b/view?usp=sharing): Sections 5.1 – 5.3 2. [Making Maps with D3](https://www.d3indepth.com/geographic/) |
| November 7 | [B2: Network and Hierarchical Data](https://canvas.wisc.edu/courses/321152/modules/688545) | 1. [Visual Analysis of Large Graphs: State-of-the-Art and Future Research Challenges](https://hal.archives-ouvertes.fr/hal-00712779) (Sections 2 – 3) 2. [ggraph Layouts](https://ggraph.data-imaginist.com/articles/Layouts.html) |
| November 14 | [B2: Network and Hierarchical Data](https://canvas.wisc.edu/courses/321152/modules/688545) | 1. [Visual Analysis of Large Graphs: State-of-the-Art and Future Research Challenges](https://hal.archives-ouvertes.fr/hal-00712779) (Sections 4 - 5) 2. [A tutorial to using d3-force from someone who just learned how to use it](https://observablehq.com/@ben-tanen/a-tutorial-to-using-d3-force-from-someone-who-just-learned-ho) |
| November 21 | [B3: High-Dimensional and Text Data](https://canvas.wisc.edu/courses/321152/modules/688546) | 1. [PCA and UMAP with tidymodels and #TidyTuesday cocktail recipes](https://juliasilge.com/blog/cocktail-recipes-umap/) 2. [Visual Interaction with Dimensionality Reduction: A Structured Literature Analysis: Sections 1, 4, and 5](https://drive.google.com/file/d/1PH7ZHHPdW_T7_mxtOMTCjEpSrytbv605/view?usp=sharing) |
| November 28 | [B3: High-Dimensional and Text Data](https://canvas.wisc.edu/courses/321152/modules/688546) | 1. [Text mining with R: Chapter 6](https://www.tidytextmining.com/topicmodeling.html) 2. Interpretation and Trust: Designing Model-Driven Visualizations for Text Analysis |
| December 5 | [B4: Uncertainty Visualization](https://canvas.wisc.edu/courses/321152/modules/688547) | 1. [Visualizing uncertainty](https://clauswilke.com/dataviz/visualizing-uncertainty.html) 2. [Slab + interval stats and geoms](https://mjskay.github.io/ggdist/articles/slabinterval.html) |
| December 12 | Conclusion | 1. [Tukey, Design Thinking, and Better Questions](https://simplystatistics.org/2019/04/17/tukey-design-thinking-and-better-questions/) 2. Optional: [A Brief History of Data Visualization](https://datavis.ca/papers/hbook.pdf) |

Teaching & Learning Data Transparency Statement

*The privacy and security of faculty, staff and students’ personal information is a top priority for UW-Madison. The university carefully evaluates and vets all campus-supported digital tools used to support teaching and learning, to help support success through*[learning analytics](https://teachlearn.provost.wisc.edu/learning-analytics/)*, and to enable proctoring capabilities. View the university’s full*[teaching and learning data transparency statement](https://teachlearn.provost.wisc.edu/teaching-and-learning-data-transparency-statement/)*.*

Privacy of Student Records & the Use of Audio Recorded Lectures Statement

*View* [more information about *FERPA*](https://registrar.wisc.edu/ferpa-facstaff/)*.*

Lecture materials and recordings for this course are protected intellectual property at UW-Madison. Students in this course may use the materials and recordings for their personal use related to participation in this class. Students may also take notes solely for their personal use. If a lecture is not already recorded, you are not authorized to record my lectures without my permission unless you are considered by the university to be a qualified student with a disability requiring accommodation. [Regent Policy Document 4-1] Students may not copy or have lecture materials and recordings outside of class, including posting on internet sites or selling to commercial entities. Students are also prohibited from providing or selling their personal notes to anyone else or being paid for taking notes by any person or commercial firm without the instructor’s express written permission. Unauthorized use of these copyrighted lecture materials and recordings constitutes copyright infringement and may be addressed under the university’s policies, UWS Chapters 14 and 17, governing student academic and non-academic misconduct.

Course Evaluations

Students will be provided with an opportunity to evaluate this course and your learning experience. Student participation is an integral component of this course, and your confidential feedback is important to me. I strongly encourage you to participate in the course evaluation.

UW-Madison uses a digital course evaluation survey tool called [AEFIS](https://kb.wisc.edu/luwmad/page.php?id=81069). For this course, you will receive an official email two weeks prior to the end of the semester, notifying you that your course evaluation is available. In the email you will receive a link to log into the course evaluation with your NetID. Evaluations are anonymous. Your participation is an integral component of this course, and your feedback is important to me. I strongly encourage you to participate in the course evaluation.

Students’ Rules, [Rights & Responsibilities](https://guide.wisc.edu/undergraduate/#rulesrightsandresponsibilitiestext)

Diversity & Inclusion Statement

[Diversity](https://diversity.wisc.edu/) is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals.The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world.

Academic Integrity Statement

By virtue of enrollment, each student agrees to uphold the high academic standards of the University of Wisconsin-Madison; academic misconduct is behavior that negatively impacts the integrity of the institution. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these previously listed acts are examples of misconduct which may result in disciplinary action. Examples of disciplinary action include, but is not limited to, failure on the assignment/course, written reprimand, disciplinary probation, suspension, or expulsion.

Accommodations for Students with Disabilities Statement

The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty [me] of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA. (See: [McBurney Disability Resource Center](https://mcburney.wisc.edu/))

[Academic Calendar & Religious Observances](https://secfac.wisc.edu/academic-calendar/)

*You can use the link above to provide your students with information about the current and future academic calendars, along with the university’s religious observance policy. As the start-date for the fall 2021 semester coincides with Rosh Hashanah, it is particularly important to reach out to your students and share your plans to provide flexibility for the first day of class.*