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**STAT 992: Multi-Omics Data Analysis**

**3 Credits**

**Course Designations and Attributes**

Natural Science

LAS Credit

Intermediate

**Course Description**

Modern biology increasingly relies on high-throughput, multi-omics data generation to solve complex scientific problems. For example, multi-omics data collection is central in current efforts to improve cancer treatment, understand the factors underlying mental health, and respond to climate change. However, managing, exploring, and drawing inference from these data is notoriously complex. Each modality reflects a different view (e.g., transcriptional, taxonomic, or chemical) of the samples under study, and simply analyzing each source separately fails to support the cross-modality comparisons of central scientific interest.

By drawing wisely from the statistical toolbox, it is possible to build more useful, integrated portraits of complex systems from multi-omics data. Moreover, with their experience comparing and critiquing data analysis procedures, statisticians have the potential to support the design of accessible and effective multi-omics workflows. This course will help you navigate the literature, giving opportunities to gain hands-on experience with the central data sources and statistical methods in the field. You will develop skill in reading, implementing, and evaluating the types of methods being actively developed for multi-omics data analysis.

**Requisites**

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

**Meeting Time and Location**

Tuesdays 11 – 11:50am, 222 Ingraham Hall.

**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/?18074495-vHppD).

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

Course Learning Outcomes

By the conclusion of the course, you will be able to,

1. Design and implement benchmarking studies (using both simulated and real data) to clarify the properties of existing multi-omics data analysis workflows.
2. Compare and contrast sequencing technologies and study designs widely used in modern multi-omic studies.
3. Write accessible technical reviews and prepare minimal code demos that translate theoretical advances in statistics to the multi-omics data analysis context.
4. Apply and critique R packages for visualization and modeling of multi-omic data.
5. Navigate the multi-omics literature, prepare academic peer reviews, and plan well-motivated research projects in the area.

**Grading**

In-Class Activities: 20%

Problem Sets: 50%

Final Project: 30%

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

Course Materials: <https://krisrs1128.github.io/stat992_s23/>

Submissions: <https://www.gradescope.com/courses/479037>

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 programming languages. We expect prior experience with the R language. Relevant resources for becoming familiar with the tools we will use are,
  + [The R Project for Statistical Computing](https://www.r-project.org/)
  + [Bioconductor Courses](https://bioconductor.org/help/course-materials/)

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

* Readings and In-Class Activities
  + You will be assigned readings drawn from research papers before each weekly course session.
  + Course sessions will include discussion and activities based on the previous week’s readings. Your contributions to each session will be scored with values in {0%, 50%, 100%}, reflecting attendance, familiarity with readings, and active participation.
* Assignments
  + There will be three major assignments over the duration of the course. You will have the opportunity to develop a real-data case study, a benchmarking experiment, and a technical review. Their deadlines are **February 14, March 7, April 11**.
* Both in-class exercises and problem sets must be submitted on [Gradescope](https://www.gradescope.com/courses/479037).
  + Your two lowest in-class activity 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.

Exams, Quizzes, Papers & Other Major Graded Work

* This class will have an individual final project asking you to prepare either an expository essay or research proposal. The intent is that these final projects can be released as a public resource for the multi-omics data analysis community. The project is due **May 10.**
* There are no exams.

**Reading Schedule**

We will cover topics in the order below and will select readings from this list, depending on student interest and background.

|  |  |
| --- | --- |
| **Week** | **Module** |
| January 24 | Orientation |
| January 31 – February 7 | Data Management |
| February 14 – 21 | Hypothesis Testing |
| February 28 – March 7 | Prediction and Dimensionality Reduction |
| March 21 – 28 | Generative Models |
| April 4 – 11 | Networks |
| April 18 – 25 | Multi-Study Analysis |
| May 3 | Conclusion |

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.*