

STA 250: METRIC STATISTICS: ANALYSIS OF OBJECT DATA

Winter 2026

Department of Statistics, UC Davis

Please read all of the following carefully as it contains important information about the course. This syllabus will be updated as changes occur, so check back occasionally.

Important contact points for students in distress:

<https://shcs.ucdavis.edu/about/contact>

<https://mentalhealth.ucdavis.edu>

Throughout this course you must adhere to the Davis Code of Academic Conduct.

Suspected violations will be reported. Please read:

<https://ossja.ucdavis.edu/code-academic-conduct>

<https://ossja.ucdavis.edu/student-conduct-and-discipline-policy>

All class work that is subject to grading must be based on your own independent work.

This course covers material that requires some familiarity with the foundational concepts in probability, mathematical statistics and regression analysis.

Instructor: Prof. Hans-Georg Müller

<http://anson.ucdavis.edu/~mueller/>

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Office hours (subject to change): In Mathematical Sciences Building (MSB) 4236 on M 3:10-4pm and Tue 3:10-4pm or by appointment.

Class Schedule: Class sessions will take place MW 4:10-6:00pm in MSB 1143. First class is on Monday, Jan. 5, last class on Wednesday, March 11. Due to UC holidays, there will be no class sessions/office hrs on Jan. 19 (Martin Luther King Day) and Feb. 16 (President's Day).

Objectives: The course provides an introduction to the emerging field of metric statistics, which deals with samples of random objects situated in a metric space. It will cover theory, applications and data analysis.

Topics: As time permits, a selection of the following topics:

1. Objects in Euclidean/Hilbert space, functional data analysis: Multivariate data and functional data; functional principal component analysis; functional regression; time warping.
2. Basic tools for metric statistics: Data in metric spaces; Fréchet means, conditional Fréchet means and Fréchet regression; distance profiles and probability measures in metric spaces.

3. Wasserstein space: Optimal transport; barycenters; distributional data analysis.
4. Geodesic metric spaces; covariance spaces; networks; transport regression
5. Object-valued stochastic processes, object time series.

Prerequisites: Background in probability and statistics, analysis and linear algebra.

Communication: In addition to Canvas, announcements and discussion of class materials will take place on Piazza. It is mandatory for students who take this course to sign up for Piazza. Students are strongly encouraged to ask questions regarding class materials and understanding by posting on Piazza (not via e-mail) and also to contribute to answering questions of fellow students. Correctly and sustainably answering questions posed by other students will accrue extra credit.

The sign-up page for Piazza is https://piazza.com/uc_davis/winter2026/sta250

Grading: Grades will be determined through the quality of in-class presentations and projects.

Projects: Projects can be an advanced data analysis or methodology development. Students will define their own projects, and start with an analysis/project plan that should be related to the class material as outlined in the lecture notes and will require approval by the instructor before the project is started. You will report on your projects in two parts: An in-class presentation that will include discussion/Q&A, followed by a brief report (limited to 5 pages, including references), that reflects the in-class presentation and discussion.

Reference texts for additional reading:

- Hsing, T, Eubank, R (2015). Theoretical Foundations of Functional Data Analysis, with an Introduction to Linear Operators. Wiley
- Wang, J. L., Chiou, J. M., Müller, H. G. (2016). Functional data analysis. Annual Review of Statistics and its application 3, 257-295.
- Petersen, A, Müller, HG (2019). Fréchet regression for random objects with Euclidean predictors. The Annals of Statistics, 47, 691-719.
- Dubey, P., Chen, Y., Müller, H. G. (2024). Metric statistics: Exploration and inference for random objects with distance profiles. The Annals of Statistics, 52, 757-792.
- van der Vaart, AW, Wellner, JA (2023). Weak Convergence and Empirical Processes. Springer
- Marron, J, Dryden, I (2022). Object Oriented Data Analysis. Routledge Chapman and Hall