

STA6557 Object Data Analysis SPRING 2026

Days/Time/Room: TT 11:35AM - 12:50PM OSB 110

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Office hours: by appointment.

Textbook: Part I *Nonparametric Statistic on Manifolds and their Applications*, by Vic Patrangenaru, Leif Ellingson, 2015, Chapman Hall/CRC, ISBN-13: 978-1439820506, ISBN-10: 1439820503 .

Part II *Nonparametric Statistic on Stratified Spaces and their Applications*, by Vic Patrangenaru, Daniel Osborne, 2026, Chapman Hall/CRC, ISBN-9781138043138.

Prerequisite: STA 5707 or equivalent

Course objectives: After completing this course, the student will be able to:

- determine what is the appropriate sample space for analyzing a given collection of observations of digital images, medical imaging outputs, shapes, unit vectors, functions, etc.
- apply key results in modern statistics, including the central limit theorems or other asymptotic theorems for nonparametric inference on manifolds
- use nonparametric statistical procedures for statistical inference, including large sample theory and nonparametric bootstrap on a smooth sample space
- analyze object data
- write a PhD essay level paper in ODA

- get a PhD level paper submitted for publication

Course description: Object data analysis is the most general type of data analysis that is known in Statistics. Technically, this is Data analysis on sample spaces with a manifold stratification. Data on manifolds originally arose in astronomy, meteorology, geology, cartography, biology and physics. A drastic increase in the need of data analysis on manifolds occurred with the computer revolution in digital imagery, and the internet. Digital images, which arguably account for the largest types of data available, are today the bread and butter of modern sciences such as Digital Image Analysis, Bioinformatics, Medical Imaging, Computer Vision, AI, Pattern Recognition, Astrophysics, Learning, Earth Sciences, Forensics, etc. Since stratified spaces are most often nonlinear spaces, fundamental statistical indices of a probability distribution on a stratified space, such as mean and covariance have to be redefined in this general context, and their estimation is naturally approached from a nonparametric perspective. The foundation of Nonparametric Statistics on stratified spaces includes large sample theory on stratified spaces, density estimation on manifolds, inference on stratified spaces, and other techniques originating from multivariate analysis. After a recollection of nonparametric multivariate analysis, and a brief rigorous introduction to abstract manifolds and manifolds as object spaces, one defines location and spread parameters for distribution on metric spaces, and proves the consistency of their sample counterparts. Hypothesis testing and density estimation on stratified spaces follow. The second part is dedicated to a nonparametric statistical analysis on certain special stratified spaces arising in statistics, such as various types of shape manifolds, Diffusion Tensor Imaging manifolds, learning manifolds, phylogenetic tree spaces, etc.

The second part focuses on concrete applications in Astronomy, Image Analysis, Medical Imaging, Bioinformatics, 3D AI Vision and 3D scene recognition, RNA based SARSCov2 analysis, Alphabet based Analysis European Languages, etc.

Grading: The course grade will be calculated on the basis of a midterm exam, (50%), and a final presentation(50%). The project is meant to be created as a draft of a paper to be submitted on ArXiv (or equivalent).

University Attendance Policy: Excused absences include documented illness, deaths in the family and other documented crises, call to active military duty or jury duty, religious holy days, and official University activities. These absences will be accommodated in a way that does not arbitrarily penalize students who have a valid excuse. Consideration will also be given to students whose dependent children experience serious illness.

Academic Honor Policy: The Florida State University Academic Honor Policy outlines the University's expectations for the integrity of students' academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to ". . . be honest and truthful and . . . [to] strive for personal and institutional integrity at Florida State University." (Florida State University Academic Honor Policy, found at <http://dof.fsu.edu/honorpolicy.htm>.)

Americans With Disabilities Act: Students with disabilities needing academic accommodation should: (1) register with and provide documentation to the Student Disability Resource Center; and (2) bring a letter to the instructor indicating the need for

accommodation and what type. This should be done during the first week of class.

This syllabus and other class materials are available in alternative format upon request.

For more information about services available to FSU students with disabilities, contact the: Student Disability Resource Center

874 Traditions Way

108 Student Services Building

Florida State University

Tallahassee, FL 32306-4167

(850) 644-9566 (voice)

(850) 644-8504 (TDD)

sdrc@admin.fsu.edu

<http://www.disabilitycenter.fsu.edu/>

Disclaimer: This syllabus provides a general plan; deviations may be necessary.