Syllabus

STAT 7630 Nonparametric Function Estimation

Spring 2025

2 Credit Hours

Course overview

Lectures

M 10:05-11:55am in Cockins Hall 228

Instructor

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- Office: Cockins Hall 440H
- Office Hours: M 4:10-5:05pm, R 2:00-2:55pm, or by appointment
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Grader

- Name: Haozhen Yu
- Office: Math Building 450
- Office Hours: by appointment only
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Course webpage

The course has a web page on Carmen (https://carmen.osu.edu/). You will find the class schedule, course announcements, homework assignments, and other information about the class on the web page. Please check it out on a regular basis.

Course description

Statistics 7630 aims to introduce a nonparametric function estimation method with roughness penalties. Starting from smoothing splines for univariate data, a unified framework for penalized likelihood approach will be developed for flexible model building with splines covering multivariate data with both Gaussian and non-Gaussian responses. Mathematical formulation of smoothing splines, reproducing kernel Hilbert space methods, selection of a smoothing parameter, computation, and their applications will be treated in detail. In addition, connection between spline models and kernel methods in machine learning (especially support vector machines) will be discussed.

Course expected learning outcomes

By the end of this course, students should successfully be able to:

1. Comprehend the mathematical formulation of smoothing splines and penalized likelihood approach in general
2. Understand the role of kernels in defining modeling procedures
3. Understand the relation between parametric and nonparametric modeling procedures
4. Understand the bias-variance tradeoff with a tunable parameter in nonparametric modeling procedures
5. Build statistical models for data using smoothing splines and kernel methods and interpret the results in the context of the data problem.

Prerequisites

Mathematical maturity in analysis and linear algebra, and a good knowledge of basic statistical inference (6802) and regression (6450/6950) are expected. Some knowledge of functional analysis (familiarity with Hilbert spaces), multivariate analysis (6560), and generalized linear models (7430) would be helpful, but not required.

Attendance Policy

You are expected to attend all lectures.

Textbooks

Required

Smoothing Spline ANOVA Models by Chong Gu (2013), 2nd edition, Springer. Available online at Springer Link through the OSU library.

Recommended

1. *Spline Models for Observational Data* by Grace Wahba. Available online through the OSU library.
2. *Nonparametric Regression and Generalized Linear Models* by Peter Green and Bernard Silverman.
3. *Learning with Kernels* by Bernhard Schölkopf and Alexander Smola. Available online through the OSU library.

Grading

There will be no in-class written exam. Course grades will be assigned on the basis of homework assignments, final project, and participation.

How your grade is calculated

Category	Percentage
Homework Assignments	50%
Final Project	40%
Participation	10%
Total	**100%**

Grading scale

While the standard grading scale generally applies, final grades may be curved upwards.

Homework assignments

Homework will be assigned regularly (about every two weeks) throughout the semester using the Assignments link on Carmen. Typically, homework assignments will involve analytical exercises, computing and data analysis. You should submit your own individual work for grading via Carmen. In addition, computer code must be separately submitted as an appendix to each assignment. Your code should include comment statements that indicate what sections of the code correspond to the specific homework questions so that, if needed, the grader can read and check your code for its accuracy. Homework solutions will be posted on the course webpage. Due dates for homework assignments will be announced on Carmen and in class.

Late assignments

No late homework assignments will be accepted with few exceptions. If you have documented reasons for missing work or needing extra time, please contact me as soon as possible prior to the due dates. Where appropriate, due dates could be extended.

Final project

The final project will consist of selecting a research paper on topics related to the main theme of the course, presenting the paper through a recorded video (by April 25), and submitting a final report (by April 28) using the Assignments page. A list of suggested papers will be provided, but students can also choose other papers in consultation with the instructor. Depending on the enrollment size, students may complete the project in groups of two members or individual projects may also be allowed. More details will be provided on the course website later.

Participation

In addition to regular class participation, there will be several activities requiring your participation for building connections with other students or formulating potential projects (e.g., posting introduction video, proposing papers for project). These activities will be announced in class and on Carmen.

Academic policies

Academic integrity policy

Although students are encouraged to work together on assignments, each student is expected to write and submit individual solutions to homework problems. Individual projects are to be completed on your own without any external help. Academic misconduct will not be tolerated and will be dealt with procedurally in accordance with university policy.

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term “academic misconduct” includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-48.7(B)). For additional information, see the Code of Student Conduct: http://studentlife.osu.edu/csc/.

Copyright for instructional materials

The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

Accessibility accommodations for students with disabilities

Requesting accommodations

The university strives to maintain a healthy and accessible environment to support student learning in and out of the classroom. If you anticipate or experience academic barriers based on your disability (including mental health, chronic, or temporary medical conditions), please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion.

If you are ill and need to miss class, including if you are staying home and away from others while experiencing symptoms of a viral infection or fever, please let me know immediately. In cases where illness interacts with an underlying medical condition, please consult with Student Life Disability Services to request reasonable accommodations. You can connect with them at slds@osu.edu; 614-292-3307; or slds.osu.edu.

Religious accommodations

Ohio State has had a longstanding practice of making reasonable academic accommodations for students' religious beliefs and practices in accordance with applicable law. In 2023, Ohio State updated its practice to align with new state legislation. Under this new provision, students must be in early communication with their instructors regarding any known accommodation requests for religious beliefs and practices, providing notice of specific dates for which they request alternative accommodations within 14 days after the first instructional day of the course. Instructors in turn shall not question the sincerity of a student's religious or spiritual

belief system in reviewing such requests and shall keep requests for accommodations confidential.

With sufficient notice, instructors will provide students with reasonable alternative accommodations with regard to examinations and other academic requirements with respect to students' sincerely held religious beliefs and practices by allowing up to three absences each semester for the student to attend or participate in religious activities. Examples of religious accommodations can include, but are not limited to, rescheduling an exam, altering the time of a student's presentation, allowing make-up assignments to substitute for missed class work, or flexibility in due dates or research responsibilities. If concerns arise about a requested accommodation, instructors are to consult their tenure initiating unit head for assistance.

A student's request for time off shall be provided if the student's sincerely held religious belief or practice severely affects the student's ability to take an exam or meet an academic requirement and the student has notified their instructor, in writing during the first 14 days after the course begins, of the date of each absence. Although students are required to provide notice within the first 14 days after a course begins, instructors are strongly encouraged to work with the student to provide a reasonable accommodation if a request is made outside the notice period. A student may not be penalized for an absence approved under this policy.

If students have questions or disputes related to academic accommodations, they should contact their course instructor, and then their department or college office. For questions or to report discrimination or harassment based on religion, individuals should contact the Office of Institutional Equity.

Policy: Religious Holidays, Holy Days and Observances

Course schedule (tentative)

Homework due dates and project due dates are tentative. Please refer to our Carmen course page for up-to-date due dates.

Week	Date	Topics/Readings	Assignments Due
1	1/6-1/10	Introduction to smoothing splines (CG 1.1, GW Foreword, GS Ch 1)	
2	1/13-1/17	Splines for interpolation and smoothing (GS 2.1–2.3), Natural splines, B-splines	
3	1/20-1/24	1/20 (M): Martin Luther King Jr. Day	1/24 (F): HW1
4	1/27-1/31	Functional analytic approach to smoothing splines (CG 2.3, GW 1.2–1.3)	
5	2/3-2/7	Characterizing the solution to the smoothing problem, Representer theorem (CG 3.1, GW 1.3)	2/7 (F): HW2
6	2/10-2/14	Influence of the tuning parameter on smoother matrix (CG 3.1, GW 1.3)	

Week	Date	Topics/Readings	Assignments Due
7	2/17-2/21	Smoothing parameter selection, cross-validation (CG 3.2, GW 4.2–4.3, GS 3.1–3.4)	2/21 (F): HW3
8	2/24-2/28	Smoothing splines as Bayes estimates (CG 2.5, GW 1.5, GS 3.8)	
9	3/3-3/7	Confidence intervals (CG 3.3, GW Ch 5), Numerical examples (CG 3.6)	3/7 (F): HW4
10	3/10-3/14	Spring Break	
11	3/17-3/21	Introduction to Reproducing Kernel Hilbert Spaces (CG 2.1, GW 1.1, SS 2.1-2.2)	
12	3/24-3/28	Properties of reproducing kernels (CG 2.1, 2.4)	3/28 (F): HW5
13	3/31-4/4	Smoothing Spline ANOVA models (CG 3.1, GW Ch 10)	4/2 (W): Project proposal
14	4/7-4/11	Generalized spline models with non-Gaussian responses (CG 5.1–5.3, GS 5.1–5.3)	

Week	Date	Topics/Readings	Assignments Due
15	4/14-4/18	Support vector machines (SS 7.1–7.3)	
16	4/21-4/25	Nonlinear support vector machines, Constrained optimization (SS 7.4–7.5)	4/25 (F): Project presentation video
17	4/28 (M)	Project report due	

Disclaimer

This syllabus should be taken as a fairly reliable guide for the course content. However, you cannot claim any rights from it and in particular we reserve the right to change due dates or the methods of grading and/or assessment if necessary. Any changes will be communicated to you through official course announcements.