浙江大學

STAT514

Mathematical Probability and Estimation

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Instructor Contact Details

Lecturer-in-charge: Dongmei Liu
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Office location: Huajiachi Campus, Zhejiang University, Hangzhou, China
Consultation Time: Book appointment by sending email to: wlwyxy_29@zju.edu.cn

Teaching Times, Modes and Locations

Course Duration: 11 Jan 2026 to 30 Jan 2026
Modes: Face-to-face
Location: Huajiachi Campus, Zhejiang University via face-to-face

Academic Level

Undergraduate

Credit Points:

The course is worth 6 units of credit point.

Credit Hours

The number of credit hours of this course equals to the credits of a standard semester- long course.

Contact Hours

The course contains a total of 53 contact hours, which consists of orientation, lectures, seminars, quiz, discussion, research, case study, small tests, assignments, on-site field trip(s), in-class and after-class activities, revision, self-study, and final exam. Students will receive an official transcript which is issued by Zhejiang University when completing this course.

Enrolment Requirements

Eligibility requires enrollment in an overseas university as an undergraduate or postgraduate student, proficiency in English, and pre-approval from the student's home institution.

Course Description:

This advanced unit explores the mathematical foundations of probability and statistical inference. Key topics include transformations and convolutions of random variables, moment generating functions, and classical distribution families such as Poisson, Normal, beta, and gamma. Students will learn parameter estimation methods including the method of moments and maximum likelihood, and explore conditional expectation, prediction, and related distributions (chi-square, t, and F). Weekly computer labs reinforce theoretical concepts through simulation techniques and applications such as the bootstrap method. This unit is ideal for students seeking a deeper mathematical understanding of statistical models and inference.

Prerequisite:

N/A

Learning Resources

- Casella, G., & Berger, R.L. (2002). Statistical Inference (2nd ed.). Duxbury. ISBN: 9780534243128.

Learning Objectives

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

- Construct and analyze probabilistic models using random variables; calculate key characteristics such as probabilities, expectations, variances, and apply suitable computational methods where needed.
- Fit statistical models to data by estimating parameters, assess uncertainty using theoretical and computational techniques (e.g. bootstrap), and evaluate model goodness-of-fit.
- Apply and prove key mathematical results related to statistical estimation theory, including inequalities and limiting behavior, in both theoretical and applied contexts.

Course Delivery:

- Face-to-face Lecture mode includes lectures, seminars, quiz, discussion, research, case study, small tests, assignments, on-site field trip(s), in-class and after-class activities, revision, and final exam.

The following course will be taught in English. There will also be guest speakers and optional field trips available for students who would like to enhance their learning experience. All courses and other sessions will be run during weekdays.

Topics and Course Schedule:

WK	Topic	Activities
1	Introduction and Orientation	Lecture; Tutorial
1	Introduction to probability theory; set theory, conditional probability, independence, Bayes' Theorem; discrete random variables.	Lecture; Tutorial
1	Common discrete distributions: Bernoulli, Binomial, Geometric, Negative Binomial, Hypergeometric, Poisson; joint and marginal distributions.	Lecture; Tutorial
1	Expectation, variance, and properties; functions of random variables; convolution and sums of independent variables.	Lecture; Tutorial
1	Inequalities (Markov, Chebyshev); Law of Large Numbers; introduction to estimation: method of moments and MLE.	Lecture; Tutorial
1	Bias, consistency, standard error; comparing estimators; delta method and asymptotic properties.	Lecture; Tutorial
2	Bootstrap methods; conditional expectation and variance; multivariate discrete distributions.	Lecture; Tutorial
2	In-class Test	Closed book
2	Continuous random variables; common distributions: Uniform, Exponential, Gamma, Normal; cumulative distribution functions.	Lecture; Tutorial
2	Transformations of random variables; joint, marginal, and conditional densities; bivariate normal distribution.	Lecture; Tutorial
2	Functions of multiple random variables; change of variables and Jacobians; Beta distribution and order statistics.	Lecture; Tutorial
3	Sampling distributions; quantiles and Q-Q plots; expectations and properties of continuous distributions.	Lecture; Tutorial
3	Covariance, correlation, prediction; estimation in the continuous case; conditional expectations and total probability.	Lecture; Tutorial
3	Moment generating functions, Central Limit Theorem; convergence in distribution; applications in estimation.	Lecture; Tutorial
3	Confidence intervals: derivation and interpretation;	Lecture; Tutorial

	bootstrap-based intervals; inference for location and scale parameters.	
3	Revision	Tutorial
	Final exam	Closed book

Assessments:

Class participation	15%
In-class Test	15%
Assignments	20%
Final exam	50%

Grade Descriptors:

HD	High Distinction	85-100
D	Distinction	75-84
Cr	Credit	65-74
P	Pass	50-64
F	Fail	0-49

High Distinction 85-100

- Treatment of material evidences an advanced synthesis of ideas Demonstration of initiative, complex understanding, and analysis.
- Work is well-written and stylistically sophisticated, including appropriate referencing, clarity, and some creativity where appropriate.
- All criteria addressed to a high level.

Distinction 75-84

- Treatment of material evidences an advanced understanding of ideas Demonstration of initiative, complex understanding and analysis Work is well-written and stylistically strong.
- All criteria addressed strongly.

Credit 65-74

- Treatment of material displays a good understanding of ideas
- Work is well-written and stylistically sound, with a minimum of syntactical errors.
- All criteria addressed clearly.

Pass 50-64

- Treatment of material indicates a satisfactory understanding of ideas Work is adequately written, with some syntactical errors.
- Most criteria addressed adequately.

Fail 0-49

- Treatment of ideas indicates an inadequate understanding of ideas Written style inappropriate to task, major problems with expression.
- Most criteria not clearly or adequately addressed.

Academic Integrity

Students are expected to uphold the university's academic honesty principles which are an integral part of the university's core values and principles. If a student fails to observe the acceptable standards of academic honesty, they could attract penalties and even disqualification from the course in more serious circumstances. Students are responsible for knowing and observing accepted principles of research, writing and any other task which they are required to complete.

Academic dishonesty or cheating includes acts of plagiarism, misrepresentation, fabrication, failure to reference materials used properly and forgery. These may include, but are not limited to: claiming the work of others as your own, deliberately applying false and inaccurate information, copying the work of others in part or whole, allowing others in the course to copy your work in part or whole, failing to appropriately acknowledge the work of other scholars/authors through acceptable referencing standards, purchasing papers or writing papers for other students and submitting the same paper twice for the same subject.

This Academic Integrity policy applies to all students of the Zhejiang University in all programs of study, including non-graduating students. It is to reinforce the University's commitment to maintain integrity and honesty in all academic activities of the University community.

Policy

The foundation of good academic work is honesty. Maintaining academic integrity upholds the standards of the University. The responsibility for maintaining integrity in all the activities of the academic community lies with the students as well as the faculty and the University. Everyone in this community must work together to ensure that the values of truth, trust and justice are upheld.

Academic dishonesty affects the University's reputation and devalues the degrees offered. The University will impose serious penalties on students who are found to have violated this policy. The following penalties may be imposed:

- ✓ Expulsion
- ✓ Suspension
- ✓ Zero mark /fail grade
- ✓ Marking down
- ✓ Re-doing/re-submitting of assignments or reports, and
- ✓ Verbal or written warning.