

Department of Statistics and Data Science
Southern University of Science and Technology
(SUSTech)

MA204: Mathematical Statistics (数理统计)

(2025 Spring Semester)

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Note: School of Business, The 3-rd Floor = SB-F3 (商学院三楼)

Lecture Hours: Monday (每周 7 – 8 节) 16:20 – 18:10
Thursday (only even week, 双周 1 – 2 节) 08:00 – 09:50
Venue: The Third Teaching Building, Room 208 (三教208), 157 Seats
Number of QQ: 722 543 392 (授课课件QQ群号码)

1. Course Objectives (课程目标)

This course is on the basis of “MA215: Probability” or “STA203 Foundation of Probability Theory” or “MA212: Probability and Statistics”. It will further study the concepts and methods of statistics. The course will lay emphasis on the estimation and hypothesis testing, the two major areas of statistical inference. Through the study of this course, students will be equipped with both quantitative skills and qualitative perceptions essential for making rigorous statistical analysis of data.

本课程是在 MA215 概率论或 STA203 概率论基础或 MA212 概率论与统计的基础上研究统计概念和统计方法的，它将着重讲述统计推断的两大主题---估计和假设检验。通过学习本课程，学生将具备定性分析，定量分析统计数据的能力。

2. Pre-requisites (先修要求)

- MA101a/102a Mathematical Analysis I/II (**MA101a/102a 数学分析 I/II**)
[或 MA101b/102b Calculus I/II (**MA101b/102/b 高等数学 A(上)/(下)**)]
- MA103b/104b Linear Algebra I/II (**MA103b/104b 线性代数上/下**)

- STA203 Foundation of Probability Theory (**STA203 概率论基础**)
 [或 MA215 Probability (**MA215 概率论**)]
 [或 MA212 Probability and Statistics (**MA212 概率论与统计**)]

3. Course Contents (教学内容)

Chapter 1. Probability and Distributions

- 1.1 Probability
- 1.2 Conditional Probability
- 1.3 Bayes Theorem
- 1.4 Probability Distributions
- 1.5 Bivariate Distributions
- 1.6 Expectation, Variance and Moments
- 1.7 Moment Generating Function
- 1.8 Beta and Gamma Distributions
- 1.9 Bivariate Normal Distribution
- 1.10 Inverse Bayes Formulae
- 1.11 Categorical Distribution
- 1.12 Zero-inflated Poisson Distribution

Chapter 2. Sampling Distributions

- 2.1 Distribution of the Function of Random Variables
- 2.2 Statistics, Sample Mean and Sample Variance
- 2.3 The t and F Distributions
- 2.4 Order Statistics
- 2.5 Limit Theorems
- 2.6 Some Challenging Questions

Chapter 3. Point Estimation

- 3.1 Maximum Likelihood Estimator (MLE)
- 3.2 Moment Estimator
- 3.3 Bayesian Estimator
- 3.4 Properties of Estimators
- 3.5 Limiting Properties of MLE
- 3.6 Some Challenging Questions

Chapter 4. Confidence Interval (CI) Estimation

- 4.1 Introduction
- 4.2 The CI of Normal Mean
- 4.3 The CI of the Difference of Two Normal Means
- 4.4 The CI of Normal Variance
- 4.5 The CI of the Ratio of Two Normal Variances
- 4.6 Large-Sample Confidence Intervals
- 4.7 The Shortest Confidence Interval

Chapter 5. Hypothesis Testing

5.1 Introduction

5.2 The Neyman–Pearson Lemma

5.3 Likelihood Ratio Test

5.4 Tests on Normal Means

5.5 Goodness of Fit Test

Chapter 6. Critical Regions and p -values for Skew Null Distributions

6.1 One–sample Chi-square Test on Normal Variance

6.2 Two–sample F Test on Normal Variances

Appendix A: Basic Statistical Distributions

Appendix B: A Unified Expectation Technique

Appendix C: The Newton--Raphson and Fisher Scoring Algorithms

4. Learning Objectives and Outcomes (教学目标)

On successful completion of the course, students should be able to:

- understand the importance of sufficient statistic(s) in data reduction and statistical inferences such as point estimation, confidence interval estimation, and testing hypothesis;
- derive maximum likelihood estimators of parameters to calculate maximum likelihood estimates;
- locate pivotal quantity to construct confidence intervals of parameters;
- find testing statistic to test hypotheses associated with one-sample and/or two-sample normal distributions with small sample sizes and non-normal distributions with large sample sizes.

成功完成该课的教学之后，学生可以达到：

- (1) 理解充分统计量在数据压缩和点估计、置信区间估计、假设检验等统计推断中的重要性；
- (2) 导出参数的极大似然估计量并且能计算极大似然估计值；
- (3) 学会通过确定枢轴量来构建参数置信区间；
- (4) 对小样本的正态分布下的单样本或者双样本，能找到假设检验的检验统计量；
对大样本的非正态分布下的单样本或者双样本，能找到假设检验的检验统计量。

5. Teaching Hours (上课安排)

The course consists of 48 lectures (3 lectures per week; 16 weeks \times 3 = 48 hours), where 12 lectures will be tutorials (12 hours).

6. Assessment (成绩评定)

- The assessment consists of five assignments (25%);
- A 2-hour written midterm test (25%);
- A three-hour written examination (50%).

7. Policy on absence from midterm/class test (期中考试缺考之规定)

- If you are or have been unable to attend the mid-term/class test, and if you wish to have a supplementary mid-term/class test, all students should write to the course lecturer giving reasons for your absence, within **7 days** of the absence.
- A supplementary midterm/class test is normally granted to those absent from the original test due to illness and with original medical certificate provided. Students absent due to other reasons, in general, are not granted a supplementary midterm/test unless with very special circumstances and with valid documental proofs provided.
- Alternatively, students absent from the midterm/class test with a reason might choose the scheme that the weight of the final examination changes from 50% to 75%.

8. Textbook (授课教材)

[1] 田国梁, 蒋学军编著 (2021). **Mathematical Statistics**. 科学出版社, 北京。

9. Main References (参考书)

[2] Miller, I. and Miller, M. (2004). **John E. Freund's Mathematical Statistics with Applications (7th Edition)**. Prentice-Hall, New Jersey.

[3] Hogg, R. V., McKean, J. W. and Craig, A. T. (2014). **Introduction to Mathematical Statistics (7th Edition)**. Pearson Education Limited.

[4] Arnold, S.F. (1990). **Mathematical Statistics**. Prentice Hall, New Jersey.

[5] Casella G. and Berger, R. L. (2002). **Statistical Inference (Second Edition)**. Duxbury Advanced Series.

[6] Rice, J. A. (2007). **Mathematical Statistics and Data Analysis (Third Edition)**. Duxbury Advanced Series.

10. Tentative Teaching Plan for MA204: Mathematical Statistics (临时的教学计划)

Week	Lecture/ Tutorial	Date		Time	Content	Assignment
1	L1	Feb 17	Mon	16:20 – 18:10	Lectures 1 & 2 (Below, §1.1 – §1.6)	
	L2					
2	L3	Feb 24	Mon	16:20 – 18:10	Lecture 3 & T1 (Below, §1.7 – §1.10)	
	T1					
	L4	Feb 27	Thu	08:00 – 09:50	§1.11 – §1.12	→A1
	L5				§2.1 (Review), B.1.1	
3	L6	Mar 03	Mon	16:20 – 18:10	B.1.2 – B.1.3	
	T2				S & E	
4	L7	Mar 10	Mon	16:20 – 18:10	B.2 , §2.2	
	L8				§2.3	
	L9	Mar 13	Thu	08:00 – 09:50	§2.4	
	T3				S & E	
5	L10	Mar 17	Mon	16:20 – 18:10	§2.5.1, §2.5.5, §2.6	A1 2.5w
	L11				§3.1.1– §3.1.3 (I)	→A2
6	L12	Mar 24	Mon	16:20 – 18:10	§3.1.3 (II), C.1	
	T4				S & E	
	L13	Mar 27	Thu	08:00 – 09:50	§3.1.4 – §3.2, C.2	
	L14				§3.3 – §3.4.1	
7	L15	Mar 31	Mon	16:20 – 18:10	§3.4.2 (I)	
	T5				S & E	
8	L16	Apr 07	Mon	16:20 – 18:10	§3.4.2 (II)	A2 3w
	L17				§3.4.3	
	L18	Apr 10	Thu	08:00 – 09:50	§3.4.4 – §3.5	→A3
	T6				S & E	
9	L19	Apr 14	Mon	16:20 – 18:10	§3.6 (I)	
	L20				C.3 (不考), C.4	
10	L21	Apr 21	Mon	16:20 – 18:10	§4.1 – §4.2	
	T7				S & E	
	L22	Apr 24	Thu	08:00 – 09:50	§4.3 – §4.5	→A4
	L23				§4.6 – §5.1.1	
11	L24	Apr 28	Mon	16:20 – 18:10	§5.1.2 – §5.1.3	A3 2.5w
	T8				S & E	
		May1-5	No classes during Labor Day holiday [劳动节假期无课]			
12	L25	May 08	Thu	08:00 – 09:50	§5.2.1	
	L26				§5.2.2	
13	L27	May 12	Mon	16:20 – 18:10	Review for MT	A4 2.5w
	T9				S & E	
	L28	May 17	Sat	07:50 – 09:50 (2 小时)	Midterm Test (Chapters 1-4)	Venue: 三教 107, 108
	L29					

14	L30	May 19	Mon	16:20 – 18:10	§5.3	→A5
	L31				§5.4.1	
	L32	May 22	Thu	08:00 – 09:50	§5.4.2 – §5.4.3	
	T10				S & E	
15	L33	May 26	Mon	16:20 – 18:10	§5.5.1 – §5.5.2	
	L34				§5.5.3	
16		Jun 02	No classes during Dragon Boat Festival holiday [端午假期无课, 但已于 May 17(周 6)补上]			
	L35	Jun 05	Thu	08:00 – 09:50	Final Review	A5 3w
	T11				S & E	
17	Exam	Jun 18	周三	Time	19:00-22:00	
				Venue	三教 206、207	

There are no classes during the Dragon Boat Festival holiday, but I made up for it on May 17th (Saturday)

11. Notes (注释)

- (1) We will give a quick review on Chapter 1 because of the overlap of this course with “STA203 Foundation of Probability Theory” or “MA215 Probability” or “MA212 Probability and Statistics”
- (2) §3.6 (II), §4.7 will not be taught. Midterm Test and Final Examination will exclude Appendix C.3 and Chapter 6.
- (3) S & E = Summary & Exercise
- (4) →A1 = To assign the first assignment [布置第一次作业]
- (5) A1|3w = To submit your first assignment within 3 weeks
[交第一次作业 (你有三周时间来完成此次作业)]
- (6) The course “MA204: Mathematical Statistics” has two classes:
Class I ---- Teaching by Gary in Bilingual, with a total of 125 students enrolled;
Class II --- Teaching by Dr. Tao LI in Bilingual, with a total of 25 students enrolled.
- (7) Midterm/Class Test of MA204 is arranged as follows:

Date: 17 May 2025 (Saturday)

Time: 7:50am – 9:50am (2 hours)

Venue: 三教107, 108 (Class I: 125 students), 三教108 (Class II: 25 students)

Seats arrangement for the Midterm/Class Test:

Randomly select seats.

- (8) You can prepare anything on one side of an A4 paper and bring it with you to the Midterm Test venue (期中考试允许带一张 A4 纸的单面笔记)。
- (9) You can prepare anything on two sides of an A4 paper and bring it with you to the Final Examination venue (期末考试允许带一张 A4 纸的两面笔记或两张 A4 纸的单面笔记)。

- (10) 期末考试总分: 100 分(正常题) + 5 分(加分题, 设计为 15% 左右的同学能做出或部分做出来) = 105 分。如果某同学期末考试得分 ≥ 100 分, 则记为 100 分。

12. Teaching Contents for the first 4 hours (前两次课的授课内容)

● Lectures 1 & 2 (§1.1 – §1.6) 之授课内容:

- (1) To introduce the Syllabus of MA204
- (2) 课程思政第1讲: South与Southern之区别
- (3) p.14, Definition 1.15, see Section 2.6 for an example, where the joint pdf of (X, Y) does not exist. Read Examples T1.3 --T1.5
- (4) p.16, Expectation of $g(X)$
- (5) p.18, Quantile and Median. Read Examples T1.6 --T1.8
- (6) p.20, Correct a typo
- (7) p. 21, Definition 1.16 and 28.1^d
- (8) p.23, Section 1.6.5
- (9) 田老师五分钟

● Lecture 3 & T1 (§1.7 – §1.10) 之授课内容:

- (1) 课程思政第2讲: 用14年创新编写《数理统计》英文教材
- (2) p.24, Definition 1.17 and 32^d. Read Example T2.2
- (3) p.27, Beta density and its support
- (4) p.30, Gamma density and its support
- (5) p.34, Definition of multivariate normal distribution
- (6) p.38, Section 1.9.4
- (7) p.40, Section 1.10
- (8) 田老师五分钟