

Hong Kong Baptist University
Faculty of Science
Department of Mathematics

Title (Units): STAT3930 ASYMPTOTICS IN STATISTICS (3,3,0)

Course Aims: To provide senior students with advanced statistics, especially some modern knowledge so that students can have a good preparation for research.

Prerequisite: Year 2 standing or above or Consent of instructor

Prepared by: Lixing Zhu

Learning Outcomes (LOs):

Upon successful completion of this course, students should be:

| No. | Learning Outcomes (LOs) |
|-----|--|
| | Knowledge |
| 1 | Able to understand the basic techniques in some parametric and nonparametric methodologies |
| 2 | Able to understand the mathematical theory |
| 3 | Able to apply the theory to study asymptotic properties of statistics |
| | Skills |
| 4 | Able to use asymptotic expansion to obtain asymptotic normality of statistics |
| 5 | Able to apply Bootstrap to some hypothesis testing problems in practice |
| 6 | Able to apply empirical likelihood to confidence interval construction |
| 7 | Able to use likelihood based methods to hypothesis testing problems |
| 8 | Able to use U-statistics theory to non-iid cases |
| | Attitude |
| 9 | Able to solve problems independently |

Assessment:

| No. | Assessment Methods | Weighting | Remarks |
|-----|--|-----------|---|
| 1 | Continuous Assessment (assignments, test.) | 30% | Assignments and test are designed to measure students understanding of the asymptotic theory in statistics. |
| 2 | Final Examination | 70% | Final Examination is designed to see how far students have achieved their intended learning outcomes especially in the Knowledge domain. Students should have a thorough understanding of the knowledge and apply them correctly in different context to do well in the exam. |

Learning Outcomes and Weighting:

| Content | LO No. | Teaching (in hours) |
|-------------------------|---------|---------------------|
| I. Asymptotic methods | 1, 3 | 5 |
| II. Estimation | 2-3, 5 | 8 |
| III. Hypothesis testing | 3, 5, 8 | 8 |
| IV. Confidence sets | 3, 7, 8 | 8 |
| V. Bootstrap | 3, 6 | 8 |
| VI. U-statistics | 3, 9 | 5 |

Textbook(optional): Jun Shao: Mathematical Statistics, 2nd edition, Springer, 2007.

Course Content in Outline:

| <u>Topic</u> | <u>Hours</u> |
|------------------------------|--------------|
| I. Asymptotic methods | 5 |
| A Introduction | |
| B Modes of Convergence | |
| C Landau's notation | |
| D Linear approximation | |
| E Applications to statistics | |

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|--|---|
| II. Estimation | 8 |
| A Maximum likelihood method under parametric model | |
| B Estimation under nonparametric models | |
| C Distribution estimation | |
| D Density estimation | |
| E Empirical likelihood | |
| F Generalized estimating equations | |
| III. Hypothesis Testing | 8 |
| A General setup | |
| B Testing under parametric models | |
| C Testing under nonparametric models | |
| D Goodness of \bar{t} test | |
| E Sign test | |
| F One-sample signed rank test | |
| G Two-sample rank test | |
| H Kolmogorov-Smirnov test | |
| I Cramer-von Mises test | |
| J Empirical likelihood ratio test | |
| IV. Confidence Sets | 8 |
| A Introduction | |
| B Pivotal quantities | |
| C Exact pivot | |
| D Asymptotic pivot | |
| E Asymptotically standard normal pivot | |
| F Inversion of tests | |
| G Confidence sets based on likelihoods | |
| H Confidence set based on sign test | |
| I Confidence band for distribution function | |
| J Empirical likelihood ratio confidence set | |
| V. Bootstrap | 8 |
| A Introduction | |
| B Bootstrap estimation | |
| C Bootstrap test | |
| D Bootstrap confidence interval | |
| VI. U-Statistics | 5 |
| A Examples and the Definition | |
| B Moments | |
| C Projection | |
| D Asymptotic properties | |