Statistical Inference

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Everything below is approximate. Please signal any corrections to Anthony.Davison@epfl.ch.

Course web page

Further material, links to data sets, etc., can be found on the course moodle page.

Lecture contents

1. Introduction, Probability revision I (12/9/24; 1–19)
    - Introduction. Probability: basic ideas, Bayes' theorem, random variables, conditional and marginal distributions, exchangeability (1–14)
    - Order statistics; moments and conditional moments; multivariate normal distribution; MGFs and KGFs. (15–19)
2. Probability revision II (19/9/24; 20–29)
    - Exponential tilting and exponential families. (19–23)
    - Convergence and delta method. Statistics revision: tasks and models. I. (24–29)
3. Statistics revision (26/9/24; 30–38)
    - Model formulation. Point estimation: some types of estimator (ML, moments, score-matching). (30–34)
    - Properties of point estimators: consistency, MSE, bias, variance. Bartlett identities. (35–38, not 37)
4. Statistics revision (3/10/24; 37–44)
    - CRLB and Fisher information. Efficient estimation. (36–38)
    - Interval estimation. Pivots. Confidence and prediction intervals. (39–44)
5. Statistics revision (10/10/24; 45–58)
    - Hypothesis testing. Bases for inference: sampling theory. (44–49)
    - Bases for inference: Bayes' theorem; randomisation. (50–58)
6. Basic notions (17/10/24; 59–76)
    - Likelihood and basic properties. Complications: selection. (59–70)
    - Complications: censoring, dependent data, missing data. (71–76)

7. Basic notions (31/10/24; 77–82)
    - Sufficiency, minimal sufficiency. Factorisation theorem. (77–79)
    - Rao–Blackwell theorem. Completeness. (80–81)
8. Basic notions (7/11/24; 83–98)
    - Eliminating nuisance parameters. Conditioning and ancillary statistics. (83–85)
    - Inference. Likelihood: generalities, consistency (86–98)
9. Likelihood theory II (14/11/24; slides 99–112)
    - Asymptotic normality of MLE. Classical regularity conditions, related statistics, exponential example (99–100)
    - Non-regular models. Vector case, profile log likelihood (101–112).
10. Likelihood theory III (21/11/24; slides 113–125)
    - Model selection. Nuisance parameters: modified profile likelihood, higher-order asymptotics (112–117)
    - Orthogonal parameters. Composite likelihood. (118–125)
11. Significance tests (28/11/24; slides 126–142)
    - Pure significance tests. Uniformity of P-value. Exact and inexact tests. (126–133)
    - Neyman–Pearson approach. Critical regions, size, power and the ROC curve. NP lemma. (134–142)
12. Multiple testing (5/12/24; slides 142–153)
    - Optimal test in exponential family. Local power and score tests. Comments/discussion of testing. (142–146)
    - Multiple testing, graphical methods. Error control. Bonferroni procedures. False discovery rate, Benjamini–Hochberg procedure. (147–155)
13. Testing. Selection. Bootstrap (12/12/24; slides 156–168)
    - Recap. Proof of BH procedure. Final comments. Selection generalities. (155–162)
    - Sample splitting; randomisation. Bootstrap intro. (163–168)
14. Bootstrap inference (19/12/24; slides 169–205)
    - Bootstrap simulation (169–187)
    - Bootstrap confidence intervals. Nonparametric delta method (187–205)