Mathematical Statistics
Topics for Exam 2024/2025

You have to be able to state the **Theorems**, which were given on the slides. Derive new relations using the knowledge given in the lecture (for example apply the Method of Moments to find estimators for normal distribution parameters).

You can take a look at your lecture notes or textbooks for 5 minutes. This opportunity will happen simultaneously and on a before agreed time. In previous years it has usually been in the middle of the exam.

1. Random variables (discrete, continuous) – definitions, examples
2. Density function and probability function (definition, properties)
3. Distribution function (definition, properties)
4. The expected value of random variables (definition, properties)
5. The variance of random variables (definition, properties)
6. Discrete and continuous distributions – Binomial, Poisson, Exponential, Normal.
7. Standard normal distribution, Standardization procedure
8. Linear combinations of independent Normal random variables
9. Population, sample
10. Theoretical random sample, point estimate, point estimator
11. Point estimation - properties (unbiasedness, consistency, efficiency), mean square error
12. Methods for parameter estimation– Maximum likelihood method, Least square method, Method of moments
    - Application to the Normal Distribution
13. Interval Estimation
    (a) Confidence interval (CI), confidence level, confidence limits
    (b) Two-sided, one-sided CI
    (c) Requirements for CI
    (d) CI for the mean in case of Single Sample
    (e) Choice of the sample size
    (f) CI for the standard deviation in case of Single Sample
    (g) CI for difference between means (Two independent samples)
    (h) CI for difference between means (Paired samples)
    (i) CI for a nonnormal distribution
14. Chi-square distribution
    (a) Characteristics
    (b) Why we need and use it

(c) Properties

(d) Theorem 1

15. t-distribution

    (a) Characteristics

    (b) Why we need and use it

    (c) Properties

    (d) Theorem 2

16. Hypothesis testing

    (a) Statistical hypotheses

    (b) Steps of hypotheses testing

    (c) Null hypothesis, alternative hypothesis

    (d) Two-sided, one-sided hypotheses

    (e) Test statistic, critical region, test of significance, level of significance

    (f) Type I error, Type II error, power function

    (g) Hypotheses about the mean of Normal distribution (z-test, t-test)

    (h) Hypotheses about the difference of two Population means (independent samples)

    (i) Hypotheses about the difference of two Population variances (F-test)

    (j) F-distribution

    (k) P-value method

    (l) Testing hypotheses using confidence intervals

17. Dependence measures between variables

    (a) Linear correlation coefficient, properties

    (b) Monotone dependence, Spearman correlation coefficient

    (c) χ^2 coefficient, its normed variants Chupproff and Cramer's coefficient

    (d) Correlation ratios

    (e) Types of variables; their relation with admissible dependence coefficients.

18. Introduction to linear regression

    (a) Where do we use linear regression?

    (b) Dependant variable, independent variable

    (c) Assumptions for linear regression

    (d) Intercept, slope, residual (error)

    (e) Interpretation of a linear model, difference between correlation coefficients

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