

STA-HC-3016

Sampling Distributions

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

5.1 Theory

5.1.1 Unit 1: *Order Statistics*: (Lectures: 8)

Introduction, distribution of the r th order statistic, smallest and largest order statistics. Joint distribution of r th and s th order statistics, distribution of sample median and sample range.

5.1.2 Unit 2: *Sampling Distributions*: (Lectures: 20)

Definitions of random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean, sample variance and sample proportion. Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region. Large sample tests, testing single proportion, difference of two proportions, single mean, difference of two means, standard deviation and difference of standard deviations by classical and p -value approaches.

5.1.3 Unit 3: *Exact sampling distributions*: (Lectures: 12)

Definition and derivation of p.d.f. of χ^2 with n degrees of freedom (d.f.) using m.g.f., nature of p.d.f. curve for different degrees of freedom, mean, variance, m.g.f., cumulant generating function, mode, additive property and limiting form of χ^2 distribution. Tests of significance and confidence intervals based on χ^2 distribution.

5.1.4 Unit 4: *Sampling distribution*: (Lectures: 20)

Student's and Fishers t -distribution, Derivation of its p.d.f., nature of probability curve with different degrees of freedom, mean, variance, moments and limiting form of t distribution. Snedecore's F -distribution: Derivation of p.d.f., nature of p.d.f. curve with different degrees of freedom, mean, variance and mode. Distribution of $1/F(n_1, n_2)$. Relationship between t , F and χ^2 distributions. Test of significance and confidence Intervals based on t and F distributions.

5.2 Practical/Lab

List of Practical

1. Testing of significance and confidence intervals for single proportion and difference of two proportions
2. Testing of significance and confidence intervals for single mean and difference of two means and paired tests.
3. Testing of significance and confidence intervals for difference of two standard deviations.
4. Exact Sample Tests based on Chi-Square Distribution.

5. Testing if the population variance has a specific value and its confidence intervals.
6. Testing of goodness of fit.
7. Testing of independence of attributes.
8. Testing based on 2 X 2 contingency table without and with Yates' corrections.
9. Testing of significance and confidence intervals of an observed sample correlation coefficient.
10. Testing and confidence intervals of equality of two population variances

SUGGESTED READING:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): *An Outline of Statistical Theory*, Vol. I, 4th Edn. World Press, Kolkata.
2. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): *An Introduction to Probability and Statistics*. 2nd Edn. (Reprint) John Wiley and Sons.
3. Hogg, R.V. and Tanis, E.A. (2009): *A Brief Course in Mathematical Statistics*. Pearson Education.
4. Johnson, R.A. and Bhattacharya, G.K. (2001): *Statistics-Principles and Methods*, 4th Edn. John Wiley and Sons.
5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): *Introduction to the Theory of Statistics*, 3rd Edn. (Reprint). Tata McGraw-Hill Pub. Co. Ltd.

STA-HC-3026**Survey Sampling and Indian Official Statistics**

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

6.1 Theory**6.1.1 Unit 1: Survey Sampling: (Lectures: 8)**

Concept of population and sample, complete enumeration versus sampling, sampling and non-sampling errors. Types of sampling: non-probability and probability sampling, basic principle of sample survey, simple random sampling with and without replacement, definition and procedure of selecting a sample, estimates of: population mean, total and proportion.

6.1.2 Unit 2: Stratified random sampling: (Lectures: 26)

Technique, estimates of population mean and total, variances of these estimates, proportional and optimum allocations and their comparison with SRS. Practical difficulties in allocation, estimation of gain in precision. Systematic Sampling: Technique, estimates of population mean and total, variances of these estimates ($N=n \times k$). Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections, introduction to PPS sampling and two stage sampling.

6.1.3 Unit 3: Ratio and Regression Method of Sampling: (Lectures: 20)

Introduction to Ratio and regression methods of estimation, first approximation to the population mean and total (for SRS of large size). Cluster sampling (equal clusters only) estimation of population mean and its variance, Concept of sub sampling.

6.1.4 Unit 4: Official Statistics: (Lectures: 6)

Present official statistical system in India, Methods of collection of official statistics, their reliability and limitations. Role of Ministry of Statistics & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), and National Statistical Commission. Government of India's Principal publications containing data on the topics such as population, industry and finance.

6.2 Practical/Lab**List of Practical**

1. To select a SRS with and without replacement.
2. For a population of size 5, estimate population mean, population mean square and population variance. Enumerate all possible samples of size 2 by WR and WOR and establish all properties relative to SRS.
3. For SRSWOR, estimate mean, standard error, the sample size
4. Stratified Sampling: allocation of sample to strata by proportional and Neyman's methods
Compare the efficiencies of above two methods relative to SRS
5. Estimation of gain in precision in stratified sampling.
6. Comparison of systematic sampling with stratified sampling and SRS in the presence of a

linear trend.

7. Ratio and Regression estimation: Calculate the population mean or total of the population. Calculate mean squares. Compare the efficiencies of ratio and regression estimators relative to SRS.
8. Cluster sampling: estimation of mean or total, variance of the estimate, estimate of intra-class correlation coefficient, efficiency as compared to SRS.

SUGGESTED READING

1. Cochran, W.G. (1984): Sampling Techniques (3rd Ed.), Wiley Eastern.
2. Sukhatme, P.V., Sukhatme, B.V. Sukhatme, S. Asok, C. (1984). Sampling Theories of Survey With Application, IOWA State University Press and Indian Society of Agricultural Statistics
3. Murthy, M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.
4. Des Raj and Chandhok, P. (1998): Sample Survey Theory, Narosa Publishing House.
5. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2001): Fundamentals of Statistics (Vol.2), World Press.
6. Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi.
7. <http://mospi.nic.in/>

STA-HC-3036

Mathematical Analysis

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

7.1 Theory

7.1.1 Unit 1: *Real Analysis*: (Lectures: 12)

Representation of real numbers as points on the line. Bounded and unbounded sets, neighborhoods and limit points, Supremum and infimum, derived sets, open and closed sets, sequences and their convergence, limits of some special sequences such as r^n , $\left(1 + \frac{1}{n}\right)^n$, and $n^{\frac{1}{n}}$ and Cauchy's general principle of convergence, Cauchy's first theorem on limits, monotonic sequences, limit superior and limit inferior of a bounded sequence.

7.1.2 Unit 2: *Infinite Series*: (Lectures: 12)

Infinite series, positive term series and their convergence; Comparison test, D'Alembert's ratio test, Cauchy's n^{th} root test, Raabe's test (For all the tests, statement only is required, without proof and applications). Absolute convergence of series, Leibnitz's test for the convergence of alternating series, Conditional convergence. Indeterminate form, L' Hospital's rule.

7.1.3 Unit 3: *Limits, Continuity and Differentiability*: (Lectures: 16)

Review of limit, continuity and differentiability, uniform Continuity and boundedness of a function. Rolle's and Lagrange's Mean Value theorems. Taylor's theorem with Lagrange's and Cauchy's form of remainder (without proof). Taylor's and Maclaurin's series expansions of $\sin(x)$, $\cos(x)$, e^x , $(1+x)^n$, $\log(1+x)$.

7.1.4 Unit 4: *Numerical Analysis*: (Lectures: 20)

Factorial, finite differences and interpolation. Operators, E and divided difference. Newton's forward, backward and divided differences interpolation formulae. Lagrange's interpolation formulae. Central differences, Gauss and Stirling interpolation formulae. Numerical integration. Trapezoidal rule, Simpson's one-third rule, three-eighths rule, Weddle's rule with error terms. Stirling's approximation to factorial n . Solution of difference equations of first order.

7.2 Practical/Lab

Practical to be done from topics contained in Unit 4 only.

SUGGESTED READINGS

1. Malik, S.C. and Savita Arora: Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International Limited, New Delhi, 1994.
2. Somasundram, D. and Chaudhary, B.: A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1987.
3. Gupta, S.L. and Nisha Rani: Principles of Real Analysis, Vikas Publ. House Pvt. Ltd., New Delhi, 1995.
4. Appostol, T.M.: Mathematical Analysis, Second Edition, Narosa Publishing House, New Delhi, 1987.
5. Shanti Narayan: A course of Mathematical Analysis, 12th revised Edition, S. Chand & Co. (Pvt.) Ltd., New Delhi, 1987.
6. Singal, M.K. and Singal, A.R.: A First Course in Real Analysis, 24th Edition, R. Chand & Co., New Delhi, 2003.
7. Bartle, R. G. and Sherbert, D. R. (2002): Introduction to Real Analysis (3rd Edition), John Wiley and Sons (Asia) Pte. Ltd., Singapore.
8. Ghorpade, Sudhir R. and Limaye, Balmohan V. (2006): A Course in Calculus and Real Analysis, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint.
9. Jain, M. K., Iyengar, S. R. K. and Jain, R. K. (2003): Numerical methods for scientific and engineering computation, New age International Publisher, India.
10. Mukherjee, Kr. Kalyan (1990): Numerical Analysis. New Central Book Agency.
11. Sastry, S.S. (2000): Introductory Methods of Numerical Analysis, 3rd edition, Prentice Hall of India Pvt. Ltd., New Del.

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STA-HG- 3016

Basics of Statistical Inference

Total Lectures: 60 Credits: 6 (Theory: 04, Practical/Lab: 02)

25.1 Theory

25.1.1 Unit 1: *Tests of Hypothesis*: (Lectures: 20)

Estimation of population mean, confidence intervals for the parameters of a normal distribution (one sample).

The basic idea of significance test. Null and alternative hypothesis. Type I & Type II errors, level of significance, concept of p-value. Tests of hypotheses for the parameters of a normal distribution (one sample), Non-parametric tests: Sign test for median, Sign test for symmetry, Wilcoxon two-sample test.

25.1.2 Unit 2: *Categorical Data Analysis*: (Lectures: 18)

Categorical data: Tests of proportions, tests of association and goodness-of-fit using Chi-square test, Yates' correction.

25.1.3 Unit 3: *Analysis of Variance*: (Lectures: 22)

Analysis of variance, one-way and two-way classification. Brief exposure of three basic principles of design of experiments, treatment, plot and block. Analysis of completely randomized design, randomized complete block design. Bioassay.

SUGGESTED READING:

1. Daniel, Wayne W., *Bio-statistics: A Foundation for Analysis in the Health Sciences*. John Wiley (2005).
2. Goon, A.M., Gupta M.K. & Das Gupta, *Fundamentals of statistics, Vol.-I & II* (2005).
3. Dass, M. N. & Giri, N. C.: *Design and analysis of experiments*. John Wiley.
4. Dunn, O.J *Basic Statistics: A primer for the Biomedical Sciences*. (1964, 1977) by John Wiley.
5. Bancroft, Holdon *Introduction to Bio-Statistics* (1962) P.B. Hoebar New York.
6. Goldstein, A *Biostatistics-An introductory text* (1971). The Macmillan New York.

PRACTICAL/LAB WORK

List of Practical

1. Estimators of population mean.
2. Confidence interval for the parameters of a normal distribution (one sample).
3. Tests of hypotheses for the parameters of a normal distribution (one sample).
4. Chi-square test of proportions.
5. Chi-square tests of association.
6. Chi-square test of goodness-of-fit.
7. Test for correlation coefficient.

8. Sign test for median.
9. Sign test for symmetry.
10. Wilcoxon two-sample test.
11. Analysis of Variance of a one way classified data
12. Analysis of Variance of a two way classified data.
13. Analysis of a CRD.
14. Analysis of an RBD.

STA – SE - 3014

Statistical Data Analysis Using Software Packages

Total Lectures: 30 Credits: 4 (Theory: 02, Practical/Lab: 02)

27.1 Theory/Practical/Lab

This course will review and expand upon core topics in statistics and probability, particularly by initiating the beneficiaries of the course to at least one of the software packages viz., Microsoft Excel, SPSS, Minitab, Matlab, for statistical computing.

27.1.1 Unit 1: Graphical Representation: (Lectures: 8)

Learn how to load data, plot a graph viz. histograms (equal class intervals and unequal class intervals), box plot, stem-leaf, frequency polygon, pie chart, ogives with graphical summaries of data

27.1.2 Unit 2: Report Generation: (Lectures: 6)

Generate automated reports giving detailed descriptive statistics, correlation and lines of regression.

27.1.3 Unit 3: Fitting Curves: (Lectures: 8)

Random number generation and sampling procedures. Fitting of polynomials and exponential curves. Application Problems based on fitting of suitable distribution, Normal probability plot.

27.1.4 Unit 4: Analysis: (Lectures: 8)

Simple analysis and create and manage statistical analysis projects, import data, code editing, Basics of statistical inference in order to understand hypothesis testing and compute p-values and confidence intervals.

SUGGESTED READING:

1. Moore, D.S. and McCabe, G.P. and Craig, B.A. (2014): Introduction to the Practice of Statistics, W.H. Freeman
2. Cunningham, B.J (2012): Using SPSS: An Interactive Hands-on approach
3. Cho, M,J., Martinez, W.L. (2014) Statistics in MATLAB: A Primer, Chapman and Hall/CRC