SCHEME OF STUDIES

AND

COURSE OUTLINE

FOR

BS STATISTICS

(5th SEMESTER INTAKE)

UNDERGRADUATE PROGRAM IN STATISTICS

(Semester/Term System)

Session 2023 –Onward

DEPARTMENT OF STATISTICS

UNIVERSITY OF SARGODHA

INTRODUCTION

Statistics is used to design surveys and experimental research, collect and analyze data, interpret and evaluate numerical evidence and communicate results. The department's aim is to provide students, to the community with high skills to play the major role in science and technology by probabilistic and statistical ideas and methods. We are focused to train research workers beyond the traditional boundaries of the discipline of statistics and encompass research in surveys, probability and statistics for decision making in areas like business, industry and society.

AIMS AND OBJECTIVES OF THE PROGRAM

a. To equip the graduates with the knowledge of statistical theory, statistical software and techniques of data collection and analysis so that they can compete in the job market and contribute towards the economic development of Pakistan.

b. To provide a sound footing of the subject matter of statistical theory so that they can pursue higher degrees and research in the field of statistics.

ELIGIBILITY

At leat 45% marks in BA/BSc/ADA/ADS or equivalent with Statistics of 200 Marks.

DURATION

The Duration required to complete this degree is 2 years

SEMESTER

Students are required to pass 4 semesters for the completion of this degree.

List of Courses of BS Statistics (5th Semester Intake)

Course Code	Course Title	Credit Hours
Foundation and Major Courses		
STAT-6301	Statistical Methods	4(3+1)
STAT-6302	Regression Analysis	4(3+1)
STAT-6303	Probability and Probability Distributions-I	3(3+0)
STAT-6304	Sampling Techniques-I	4(3+1)
STAT-6305	Design and Analysis of Experiment-I	4(3+1)
STAT-6306	Econometrics	4(3+1)
STAT-6307	Statistical Packages	3(3+0)
STAT-6308	Probability and Probability Distributions-II	3(3+0)
STAT-6309	Sampling Techniques-II	4(3+1)
STAT-6310	Design and Analysis of Experiment-II	4(3+1)
STAT-6311	Statistical Inference-I	3(3+0)
STAT-6312	Applied Multivariate Analysis	4(3+1)
STAT-6313	Research Methods/Internship	3(3+0)
STAT-6314	Non Parametric Methods	3(3+0)
STAT-6315	Population Studies	4(3+1)
STAT-6316	Statistical Inference-II	3(3+0)
STAT-6317	Project/Research Report	3(3+0)
Elective Courses		
STAT-6318	Statistical Quality Control	3(3+0)
STAT-6319	Time Series and Forecasting	3(3+0)
STAT-6320	Official Statistics	3(3+0)
STAT-6321	Bio-Statistics	3(3+0)
STAT-6322	Robust Methods	3(3+0)
STAT-6323	Operation Research	3(3+0)
STAT-6324	Mathematical Models and Simulation	3(3+0)
STAT-6325	Numerical Methods	3(3+0)
STAT-6326	Categorical Data Analysis	3(3+0)
STAT-6327	Stochastic Process	3(3+0)
STAT-6328	Reliability Analysis	3(3+0)
STAT-6329	Survival Analysis	3(3+0)
STAT-6330	Actuarial Statistics-I	3(3+0)
STAT-6331	Bayesian Statistics	3(3+0)
STAT-6332	Decision Theory	3(3+0)
STAT-6333	Data Mining	3(3+0)
STAT-6334	Actuarial Statistics-II	3(3+0)

MODEL SCHEME OF STUDIES FOR BS STATISTICS
(5th Semester Intake)

SEMESTER-I			
STAT-6301	Statistical Methods	4(3+1)	F
STAT-6302	Regression Analysis	4(3+1)	M
STAT-6303	Probability and Probability Distributions-I	3(3+0)	F
STAT-6304	Sampling Techniques-I	4(3+1)	F
STAT-6305	Design and Analysis of Experiment-I	4(3+1)	M
	Total	**19(15+4)**	
SEMESTER-II			
STAT-6306	Econometrics	4(3+1)	M
STAT-6307	Statistical Packages	3(3+0)	F
STAT-6308	Probability and Probability Distributions-II	3(3+0)	M
STAT-6309	Sampling Techniques-II	4(3+1)	M
STAT-6310	Design and Analysis of Experiment-II	4(3+1)	M
	Total	**18(15+3)**	
SEMESTER-III			
STAT-6311	Statistical Inference-I	3(3+0)	M
STAT-6312	Applied Multivariate Analysis	4(3+1)	M
STAT-6313	Research Methods/Internship	3(3+0)	M
STAT-6314	Non Parametric Methods	3(3+0)	M
STAT-63**	Elective Course	3(3+0)	E
STAT-63**	Elective Course	3(3+0)	E
	Total	**19(18+1)**	
SEMESTER-IV			
STAT-6315	Population Studies	4(3+1)	M
STAT-6316	Statistical Inference-II	3(3+0)	M
STAT-6317	Project/Research Report	3(3+0)	M
STAT-63**	Elective Course	3(3+0)	E
STAT-63**	Elective Course	3(3+0)	E
	Total	**16(15+1)**	

GRAND TOTAL: 72

F : For Foundation Courses Number of Courses=04
M: For Major Courses Number of Courses=13
E : For Elective Courses Number of Courses=04
**** : From the List of Elective Courses**

STAT-6301 Statistical Methods 4(3+1)

Statistical methods used in practice are based on a foundation of statistical theory. One branch of this theory uses the tools of probability to establish important distributional results that are used throughout statistics. The application of statistical methods extracts information from research data and provides different ways to assess the robustness of research outputs. Another major branch of statistical theory is statistical inference. The course covers a wide range of statistical methods. The aim of this course is to provide a strong mathematical and conceptual foundation in the methods of statistical method, probability distribution and statistical inference with an emphasis on practical aspects of the interpretation and communication of statistically based conclusions in research. This course enables students to understand about set theory, role of set theory in probability discipline, events, probability of an events, random variables, types of random variables and their distribution. Some topics include hypothesis testing, and multiple regression analysis. This is a calculus-based course. It also involves derivation of power functions of different tests for comparing and evaluation of the tests. The application of statistical methods extracts information from research data and provides different ways to assess the robustness of research outputs.

Contents

1. Applications of standard discrete and continuous distributions: Binomial, Hyper-geometric, Multinomial, Negative Binomial, Geometric, Poisson,
2. Exponential and Normal probability distributions.
3. Basic ideas about sampling distributions with particular reference to normal, chi-square, t and F distributions.
4. Basic ideas of statistical inference, Point and interval estimation, Confidence intervals, testing of hypotheses. Simple and composite hypotheses.
5. Calculation of type I and type II errors, Power of a test, Operating characteristic (OC) function.
6. Inferences about means, proportions and variances.
7. Determination of Sample Size. P-Value.
8. Inference about regression coefficient for simple and multiple linear regressions up to three variables.
9. Standard error of estimate. Coefficient of determination.
10. Linear correlation.
11. Multiple and Partial correlation.
12. Confidence intervals for regression and correlation coefficients.
13. Sequential test. Test for proportion. Operating Characteristic (OC) function. Average sample number (ASN) function. Test for standard deviation.

Recommended Texts

1. Hogg, R. M. & Craig, A. T. (2013). *Introduction to mathematical statistics* (7thed.). Prentice Hall.
2. Steel, R.G.D. &Torrie, J.H. (1980). *Introduction to statistical analysis* (2nded.). New York: McGraw-Hil.

Suggested Readings

1. Wilcox, R. (2001). *Fundamentals of modern Statistical methods*. New York: Springer.
2. Larson, H.J. (1982). *Introduction to Probability Theory and Statistical Inference* (3rded.). New York: John Wiley and Sons.
3. Vaidyanathan, M. (2001). *Latest statistical methods.* New Dehli: S. Chand and Company.

STAT-6302 **Regression Analysis** **4 (3+1)**

This course covers fitting and evaluating linear regression models (simple regression, multiple regression, and hierarchical regression), including assessing the overall quality of models and interpreting individual predictors for significance. R-Square is explored in depth, including how to interpret R-Square for significance. Together with coverage of simple, multiple and hierarchical regression, we'll also explore the correlation, an important statistical procedure that is closely related to regression. It aims to emphasize both the theoretical and practical aspects of statistical modeling typically focusing on the techniques for estimating regression models of different kinds. It also enlightens the applications of different prediction models utilized in the both long-term and short-term time period. This covers statistical methods related to modeling based strategies and cause and effect terminology. By the end of this course students will be skilled in running and interpreting their own linear regression analyses, as well as critically evaluating the work of others. Examples of running regression on some statistical software like SPSS, Minitab, Mathematica and R programs are provided.

Contents

1. Introduction to regression and its types
2. Introduction to correlation and its types
3. Simple and multiple linear regression models
4. Linear regression and its assumptions,
5. Least squares estimator,
6. Maximum Likelihood Estimator,
7. Tests of significance for regression model and regression parameters.
8. Confidence interval for regression parameters,
9. Interval estimation for predicted response
10. Regression models with single and multiple qualitative predictors
11. Stepwise regression and regression model selection criteria's
12. Test of linearity of regression, Use of extraneous information in linear regression model.
13. Residual analysis, Detection and study of outliers and influential observations,
14. Polynomial regression,
15. Orthogonal polynomial, orthogonal regression analysis and Specification of models

Recommended Texts

1. Draper, N. R. & Smith, H. (2004). *Applied regression analysis*. New York: John Wiley & Sons.
2. Montgomery, D. C., Peck, E. A. & Vining, G. G. (2012).*Introduction to linear regression analysis.*New York: John Wiley & Sons.

Suggested Readings

1. Rawlings, J. O., Pantula, S. G. & Dickey, D. A. (2001).*Applied regression analysis: A research tool*. USA: Springer.
2. Dielman, T. E. (2001).*Applied regression analysis for business and economics*. Pacific Grove.
3. Yan, X., &Zu, X. G. (2009).*Linear regression analysis: Theory and computing*. World Scientific Publications.

STAT-6303 Probability and Probability Distributions-I 3(3+0)

Probability theory is the branch of mathematics that deals with modeling uncertainty. Probability distribution indicates the likelihood of an event or outcome. It is important because of its direct application in areas such as genetics, finance and telecommunications. It also forms the fundamental basis for many other areas in the mathematical sciences including statistics, modern optimization methods and risk modeling. This course is designed to establish conceptual framework ofhandling and understanding uncertain events probability and probability distributional approach, basic probability axioms and rules and the moments of discrete and continuous random variables as well as be familiar with commonly named discrete and continuous random variables. This course enables the students to understand how to derive the probability density function of transformations of random variables and use these techniques to generate data from various distribution, how to calculate probabilities, and derive the marginal and conditional distribution of bivariate random variables. Methods on computations on Total probability theorem and Bayes theorem with implementation on the real life phenomenon are also provided. This course enables students how to derive distribution of functions of random variables by using the cumulative distribution function, transformation and m.g.f techniques.

Contents

1. Probability as a set function, Conditional Probability
2. Bayes' theorem, Chebychev's inequality.
3. Random Variables, Distribution function and Probability density function
4. Joint distributions
5. Probability density functions of two or more random variables
6. Marginal and conditional distributions
7. Stochastic independence
8. Mathematical expectations
9. Conditional expectations.
10. Variance and moments
11. Probability generating functions, Moment generating functions
12. Characteristics function and their existence properties.
13. Relation between moments and cumulants,
14. Standard Probability distributions, Binomial, Poisson,
15. Hyper geometric, Multinomial, Negative Binomial, Geometric,
16. Uniform, Exponential distributions
17. Beta, Gamma and Normal distributions and their moments generating and characteristic functions.

Recommended Texts

1. Hogg, R. M. & Craig, A. T. (2013). *Introduction to mathematical statistics* (7thed.). New York: Prentice Hall.
2. Stuart, A.&Ord, J. K. (1998). *Kendal's advanced theory of mathematical statistics*(1st ed.). London: Charles Coriffi and Co.
3. Mood, A. M, Graybill, F. A. &Boes, D.C. (1997). *Introduction to the theory of Statistics*. New York: McGraw Hill.

Suggested Readings

1. John, R. 2006). *Mathematical statistics and data analysis*. Duxbury Press.
2. Khan, M. K. (1996). *Probability with applications*.Lahore: MaktibaIlmi.
3. Scheaffer, R.L. (1990*). Introduction to probability and its applications*. Kent: PWS.

STAT-6304 Sampling Techniques-I 4(3+1)

A *sampling technique* is the name or other identification of the specific process by which the entities of the *sample* have been selected. Sampling techniques are an important source of statistical data. A great many published statistics on demographic, economic, and political and health related characteristics are based on survey data. Simple random sampling is a well-known method of sampling but, for reasons of efficiency and practical constraints, methods such as stratified sampling and cluster sampling are typically used by statistical authorities such as the Australian Bureau of Statistics and by market research organizations.A well designed sampling procedure ensures that we can summarize and analyze data with a minimum of assumptions and complications. This course deals with the basic concepts of sampling, requirements of a good sample, determination of sample size etc. The course provides the mathematical and conceptual formation of sampling techniques especially for simple random sampling and stratified random sampling which are the types of probability sampling. Ratio and regression estimates in simple random sampling are also the parts of the contents. This course is designed for the different types of sampling and selection and estimation procedures.

Contents

1. Basic concepts, advantages of sampling method, requirements of a good sample,
2. Bias, sampling and non-sampling errors.
3. Steps and problems involved in planning and conduct of census and sample surveys.
4. Selection and estimation procedures.
5. Description and properties of simple random sampling for properties and percentages.
6. Estimation of variances, standard errors
7. Confidence limits.
8. Sample size determination under different conditions.
9. Description and properties of stratified random sampling.
10. Formation of strata
11. Different methods of allocation sample size,
12. Systematic sampling.
13. Description and properties systematic sampling
14. Ratio and regression estimates in simple RS
15. Ratio and regression estimates in stratified random sampling.

Recommended Texts

1. Lohr, S. L. (2010). *Sampling design and analysis*(2nd ed.). Cole: Brooks.
2. Des, R.&Chandhok, P. (1998). *Sample survey theory*. New Delhi: Narosa Publishing House.
3. Cochran, W.G. (1996). *Sampling techniques*. New York: John Wiley & Sons.

Suggested Readings

1. Scheaffer, R. L., Mendenhall, W., Ott R. L. &Gerow, K. G. (2012). *Elementary survey sampling*.(7th ed.). Cole: Brooks
2. Sukhatme, P.V., Sukhatme, B., Sukhatme, S. &Asok, A. (1985). *Sampling theory of survey with application*. Lowa State: University Press.
3. Barnett, V. (2002). *Sample survey principles and methods*(3rd ed.). New York: John Wiley & Sons.
4. Särndal, C. E., Swensson, B. &Wretman, J. (2003). *Model assisted survey sampling*.USA: Springer

STAT-6305 Design and Analysis of Experiments-I 4(3+1)

The aim of this course is to deliver the applicable knowledge about Statistics and Experimental Design, which can apply in different fields of study and to develop a skills on the data collection from a designed experiment, description measures of data, interpretation of results, and decision making. It deals with a thorough introduction to statistical experimental design, and the statistical methods used to analyze the resulting data. The concepts of comparative experiments, ANOVA and mean separation procedures will be reviewed; blocking (complete and incomplete) will be discussed, the derivations of different Experimental Designs and its applications in different fields. It also discusses the estimation of missing observations in basic designs. Various designs are discussed and their respective differences, advantages, and disadvantages are noted. This covers Layout analysis and related efficiency of completely randomize, randomized complete block, Latin square, Greco Latin square and Cross-over designs. Multiple comparisons tests and Analysis of covariance are part of the contents. At the end of the semester, students will be trained in statistical modeling and in the choice of experimental designs for use in scientific investigations. More specifically, students will be able to design and conduct an experiment.

Contents

1. Principles of experimental design
2. One way and Two way classification
3. Layout and analysis and related efficiency
4. Completely randomized complete block, its layout and analysis
5. Latin square Design, its layout and analysis
6. Greco Latin Square Design
7. Cross-over designs
8. Estimation of missing observations in basic designs.
9. Fixed effect models
10. Random effect models.
11. Mixed effect models
12. Multiple comparisons tests
13. Effect of violation of assumptions underlying ANOVA
14. Transformation of data.
15. Analysis of covariance.

Recommended Texts

1. Montgomery, D. C. Sons (2019). *Design and analysis of experiments* (10thed.). New York: John Wiley &Sons.Clarke, G. M. &Kempthon, R. E. (1997). *Introduction to the design and analysis of experiments*. London: Edward Annold.

Suggested Readings

1. Bland, M. (2015). *An Introduction to medical statistics* (4thed.). Oxford: University Press.
2. Matthews, N. S. (2006).*Introduction to randomized controlled clinical trials* (2nded.).London: Chapman and Hall.
3. Boniface, D. R. (1995). *Experiment design and statistical methods*. London: Chapman and Hall.

STAT-6306 **Econometrics** **4 (3+1)**

This course introduces the regression methods for analyzing data in economics. This is an introductory course in the theory and practice of classical Econometric Methods. The main components of the course deal with Single Equation Models, Dynamic Equation Models, Instrumental Variable Estimation and Multiple Equation Models. This course emphasizes both the theoretical and the practical aspects of statistical analysis, focusing on techniques for estimating econometric models of various kinds and for conducting tests of hypotheses of interest to economists. Some basic knowledge of matrix algebra and elementary statistical theory will be assumed, but a lot of it will be re-introduced during the lectures. The goal of this course is to help the students to develop a solid theoretical background in introductory level econometrics, the ability to implement the techniques and to critique empirical studies in economics. The computer is a fundamental tool in this course and students will be required to become familiar with some statistical software such as R, Eviews, STATA to analyze the econometric data and fitting of econometric models.

Contents

1. Introduction to econometrics.
2. Econometrics data types.
3. Autocorrelation: Definition, reasons, consequences, tests and solutions
4. Multicollinearity: Definition, reasons, consequences, tests and solutions
5. Heteroscedasticity: Definition, reasons, consequences, tests and solutions
6. Ridge regression.
7. Autoregressive and distributed lagged models
8. Dummy variables, Errors in Variables, Instrumental variables.
9. System of simultaneous equations.
10. Identification-Estimation method.
11. Indirect and two-stage least squares methods.
12. Three-stage least square estimation
13. Restricted least squares.
14. Test of identifying restrictions; Estimation with stochastic regressor,
15. Generalized least squares estimators.
16. Introduction to generalized linear models

Recommended Texts

1. Gujrati, D. (2004). *Basic econometrics.* (4^{th}ed.). New York: John Wiley & Sons.
2. Draper, N. R. & Smith, H. (2004). *Applied regression analysis*. New York: John Wiley & Sons.

Suggested Readings

1. Baltagi, B. H. (2011). *Econometrics* (5^{th}ed.). USA: Springer.
2. Johnston, J. &Nardo, J. (1997). *Econometric method (*4^{th}ed.). New York: McGraw Hill.
3. Koutsoyiannis, A. (1980). *Theory of econometrics.* Macmillan.

STAT-6307 **Statistical Packages** **3 (3+0)**

This course provides an understanding to tackle real life variables as well as the artificial environment of random variables by simulating on different software. After studying this course, student will be able to understand about inserting, coding, sorting, filtering and grouping variables on SPSS. It deals with implementing statistical tools like all measures of central tendency, dispersions, graphical procedures, measures of correlational structures Simple and Multiple Regression and various estimation and testing procedures. Computation of probability of different events and dealing with probability distributions are also of major concerns. It also discuss how to perform time series analysis on SPSS, MINITAB and Eviews. This course also signifies how to perform complex statistical analysis like principal component analysis, factor analysis, culture analysis and discernment analysis on different software. Methods to simulate any random variable or statistic and identifying distribution of random variables are also provided in this course.

Contents

1. Introduction to SPSS.
2. Introduction to Minitab.
3. Data manipulation in Minitab, graphical representation in Minitab, Qualitatively and Quantitative data presentation and analyzing data using Minitab.
4. Regression modeling with Minitab
5. Design of experiments using Minitab
6. Statistical quality control with Minitab
7. Time Series Analysis using Minitab
8. Programming and simulation in R.
9. Introduction of SPSS, data manipulation in SPSS.
10. Simple arithmetic in SPSS, SPSS function related to probability distributions, SPSS modules, simple graphing in SPSS.
11. Analysis using SPSS syntax programming.
12. Use of Eviews.

Recommended Texts

1. Ryan, B. F., Joiner, B. L. &Cryer, J. D.(2005). *Minitab handbook* (5th ed.). California: Duxbury Press.
2. Delwiche, L. D. & Slaughter, S. J. (1998).*The little SAS book:A primer*(2nd ed.). North Carolina: SAS institute.

Suggested Readings

1. Crawley, M. J. (2007). *The R book*. New York: John Wiley& Sons.
2. IBM SPSS. (2011). *IBM SPSS statistics 19.0 core system user's guide*. Prentice Hall.
3. Vogelvang, B. (2005). *Econometrics: Theory and applications with eviews.* Financal Times Management.

STAT- 6308 Probability and probability distribution-II 3(3+0)

A probability distribution is a statistical function that describes all the possible values and likelihood that a random variable can take within a given range. These factors include the distribution's mean (average), standard deviation, skewness, and kurtosis. Probability distribution is a fundamental concept in statistics. They used both on a theoretical level and a practical level. Some practical uses of probability distributions are: To calculate confidence intervals for parameters and to calculate critical regions for hypothesis tests. In life there is no certainty about what will happen in the future but decisions still have to be taken. Therefore, decision processes must be able to deal with the problems of uncertainty. Uncertainty creates risk and this risk must be analyzed. The aim of the course is to provide the conceptual and mathematical formation of Continuous probability and other distribution with their derivation and properties. This course is designed for continuous probability functions and their applications. It deals with probability generating functions and moment generating function and their properties. Order statistics, Chi-square, t, F distributions and inequalities are also the part of content. The course focuses on mathematical formation of Continuous probability distribution and bivariate normal distribution.

Contents

1. Properties of Cauchy, Laplace, Weibull, Maxwell, Pareto, Raleigh and Log normal distributions.
2. Bivariate Normal distribution
3. Transformation of variables,
4. Cumulative distribution function and moment generating function techniques,
5. Central limit theorem.
6. Order Statistics,
7. Distribution of rth&sth order Statistics,
8. Distribution of median, range and quantiles
9. Methods of deriving exact sampling distribution for a population.
10. Independence of sample mean & variance.
11. Central t, F and chi-square distributions
12. Non-central t, F and chi-square distributions,
13. Distribution of Quadratic Forms
14. Distributions under linear constraints
15. Standard error of estimates in large sample (Variance, St. Dev. & Corr. Coeff.).

Recommended Texts

1. Leon, G.(2008). *Probability, statistics, and random processes for electrical engineering* (3rd ed.). Wisconsin: Prentice-Hall.
2. Stuart, A. &Ord, J. K. (1998). *Advanced theory of mathematical statistics.* (1st ed.). London: Charles Coriffi and Co.
3. Bickel, P. J. &Docksum, K. A. (1997). *Mathematical statistics.*New York: Holden Day Inc

Suggested Readings

1. Sheldon, R**.** (2010). *Introduction to probability models***.** Academic Press.
2. Hogg, R. M. & Craig, A. T. (1995). *Introduction, to mathematical statistics*. New York: MacMillan Co.
3. Grimmett&Stirzaker. (2001). *Probability and random processes***.** (3rd ed.). Oxford: Press.
4. Peebles, P. (2001). *Probability, random variable and random signal processing*. (4th ed.). London: McGraw-Hill.

STAT-6309 Sampling Techniques-II 4(3+1)

Sample surveys are an important source of statistical data. A great many published statistics on demographic, economic, and political and health related characteristics are based on survey data. Simple random sampling is a well-known method of sampling but, for reasons of efficiency and practical constraints, methods such as stratified sampling and cluster sampling are typically used by statistical authorities such as the Australian Bureau of Statistics and by market research organizations.A well designed sampling procedure ensures that we can summarize and analyze data with a minimum of assumptions and complications.The aim of this course is to cover sampling design and analysis methods that would be useful for research and management in many fields and to develop your understanding of the principles and methods. This course is concerned with the design of sample surveys and the statistical analysis of data collected from such surveys. The course provides the mathematical and conceptual formation of sampling techniques especially for Cluster sampling, Double Sampling, Multistage or Multiphase sampling and different estimator's comparison. Non response or Randomized response and their sources are also the parts of the contents. This course is designed for the different types of sampling and selection and estimation procedures.

Contents

1. Cluster sampling
2. Cluster sampling and its analysis along with examples
3. Sub sampling
4. PPS-Sampling.
5. Double sampling
6. Multistage sampling
7. Multiphase sampling.
8. Thomson Hurwitz estimator
9. Thomson Hurwitz estimator and its applications
10. Comparison of different sample designs.
11. Critical study of National sample surveys conducted in Pakistan.
12. Census of Agriculture
13. Household Economic and Demographic Survey (HED), Household
14. Income and Expenditure Survey (HIES)
15. Pakistan Demographic Survey (PDS)
16. Nation population and housing census surveys (NPHCS).

Recommended Texts

1. Lohr, S. L. (2009). *Sampling: design and analysis*. London: Duxbury Press.
2. Des, R., &Chandhok, P. (1998). *Sample survey theory*. New Dehli: Narosa Publishing House.
3. Cochran, W.G. (1996). *Sampling techniques*. New York: John Wiley and Sons.

Suggested Readings

1. Ferguson, T. S. (1996). *A course in large sample theory*. London: Chapman and Hall.
2. Sukhatme, P.V., Sukhatme, B., Sukhatme, S. &Asok, A. (1985).*Sampling theory of survey with application*. Lowa State: University Press.
3. Des, R. (1998). *Design of sample survey*. New York: McGraw Hill.
4. Levy, P.S.&Lemeshow, S. (1999). *Sampling of populations: Methods and Applications*(3rd ed.). New York: Wiley Interscience.

STAT-6310 Design and Analysis of Experiments-II 4(3+1)

Data for statistical studies are obtained by conducting either experiments or surveys. Experimental design is the branch of statistics that deal with the design and analysis of experiments. The methods of experimental design are widely used in the fields of agriculture, medicine, biology, marketing research, and industrial production**.** One or more of these variables, referred to as the factors of the study are controlled so that data may be obtained about how the factors influence another variable referred to as the response variable, or simply the response. The aim of this course is to deliver the applicable knowledge about Statistics and Experimental Design, which can apply in different fields of study and to develop a skills on the data collection from a designed experiment, description measures of data, interpretation of results, and decision making. It deals with the model estimation of parameters of Factorial Experiments, 2^n, 3^n… P^n and mixed levels factorial experiments and its applications in different fields. This covers Confounding and its types, Fractional replication, Quasi-Latin squares, Split-plot, Split Split plot, split block and Incomplete Block Designs. Models and applications of 1^{st} and 2^{nd} order response surface designs are part of the content.

Contents

1. Factorial Experiments, 2^n, 3^n… P^n
2. Mixed levels factorial experiments:
3. Model estimation of parameters with applications.
4. Confounding and its types,
5. Fractional replication
6. Quasi-Latin squares,
7. Split-plot design
8. Split Split plot and split block designs,
9. Incomplete Block Designs
10. Balanced incomplete block designs
11. Partially balanced incomplete block designs
12. Balanced Lattices
13. Lattice squares; models and Analysis,
14. 1st and 2nd order response surface designs, their models and applications.
15. Youden Squares; models and Analysis,
16. 1st and 2nd order response surface designs, their models and applications.

Recommended Texts

1. Montgomery, D. C. (2019). *Design and analysis of experiments*. (10^{th}ed.). New York: John Wiley Sons.
2. Clarke, G. M. &Kempthon, R. E. (1997). *Introduction to the design and analysis of experiments.* England: Edward Annold.

Suggested Readings

1. Bland, M. (2015). *An Introduction to medical statistics* (4^{th}ed.). Oxford: University Press.
2. Matthews, N. S. (2006).*Introduction to randomized controlled clinical trials* (2^{nd}ed.).New York: Chapman and Hall.
3. Boniface, D. R. (1995). *Experiment design and statistical methods*. New York:Chapman and Hall.
4. Clarke, G.M. (1994). *Statistics and experimental design*. England: Edward Annold.

STAT-6311 Statistical Inference I 3(3+0)

Statistical inference is the process of drawing conclusions about populations or scientific truths from data. There are many modes of performing inference including statistical modeling, data oriented strategies and explicit use of designs and randomization in analyses. A key step in the Statistical Investigation Method is drawing conclusions beyond the observed data. Statisticians often call this "statistical inference. A practitioner can often be left in a debilitating maze of techniques, philosophies and nuance. This course presents the fundamentals of inference in a practical approach for getting things done. The main objective of this course is to provide a strong mathematical and conceptual foundation in the methods of statistical inference, with an emphasis on practical aspects of the interpretation and communication of statistically based conclusions in research. Statistical estimation is concerned with the best estimating a value or range of values for a particular population parameter. It deals with the estimation of parameters, properties of good point estimator and its methods. It also discusses the parameter estimation of different probability distributions and their efficiency. Bayesian Statistics and its comparison with classical estimation approach are part of the content.

Contents

1. Methods of Estimation,
2. Method of least squares,
3. Method of moments.
4. Minimum chi-square.
5. Maximum likelihood
6. Bayes methods.
7. Estimates based on order statistic.
8. Observations, Simultaneous confidence intervals.
9. Properties of a good estimator
10. Unbiased
11. Consistency
12. Sufficiency
13. Efficiency.
14. Completeness
15. Minimum Variance Unbiased Estimator.
16. Rao-Black well theorem
17. Lehmann sheffe theorem with applications.
18. Cramer-Rao Inequality.

Recommended Texts

1. Hogg, R. M. & Craig, A. T. (2019). *Introduction to mathematical statistics.* (7th ed.).New York: MacMillan Co.
2. Mood, A. M., Graybill, F. A. &Boes, D.C. (1997). *Introduction to the theory of statistics*. London: McGraw Hill.

Suggested Readings

1. Lehmann, E. L. (1986).*Testing statistical hypotheses*. New York: John Wiley & Sons.
2. Hirai, A. S. (1973). *Estimation of statistical parameters*. Pakistan: IlmiKhana.
3. Lindgren, B.W. (1998). *Statistical theory*. New York: Chapman and Hall.
4. Stuart, A. &Ord, J. K. (1998). *Kendall's' advanced theory of statistics* (2nd ed.) London: Charles Griffin.

STAT-6312 Applied Multivariate Analysis 4(3+1)

Multivariate analysis is used to study more complex sets of data than what univariate analysis methods can handle. Essentially it is a tool to find patterns and relationships between several variables simultaneously. It lets us predict the effect a change in one variable will have on other variables. Multivariate analysis can reduce the likelihood of Type I errors. Sometimes, univariate analysis is preferred as multivariate techniques can result in difficulty interpreting the results of the test. This course is designed to enlighten the significance of multivariate analysis by entertaining the both mathematical and applied approaches of problems. This course deals with multiple variable analyses simultaneously. To impart skills on the data collection, description measures of data, interpretation of the results, model selection, decision making in the context of multivariate analysis. Nowadays, to accommodating, monitoring, sorting, and filtering, several variables in various fields like in manufacturing industries, social phenomenon, psychology, medical, information technology and biotechnology etc. simultaneously is a big challenge to the world. This is designed to enlighten the significance of multivariate analysis by entertaining the both mathematical and applied approaches of problems. Course also provides the simultaneous model structure, their assumptions and mathematical derivations of multivariate statistical designs.

Contents

1. Multivariate Normal Distribution.
2. Distribution of linear function of normal variates.
3. Distribution of Quadratic forms
4. MLE of Multivariate Normal Distribution
5. Wishart distribution.
6. Hotelling's T^2-distribution
7. Inferences about mean vector
8. Inferences about covariance matrices
9. Inferences about profiles
10. Canonical variates Analysis.
11. Discriminant Analysis
12. Principle Component Analysis
13. Factor Analysis.
14. Factor analysis versus principle component analysis
15. Cluster Analysis
16. MANOVA.

Recommended Texts

1. Johnson, R. A., &Wichern, D. W. (2002). *Applied multivariate statistical analysis* (5^{th}ed.). New Jersey: Prentice hall.
2. Gnanadesikan, R. (1997). *Methods for data analysis of multivariate observations* (2^{nd}ed.). New York: John Wiley and Sons.

Suggested Readings

3. Anderson, T.W. (1985). *An introduction to multivariate statistical analysis*. New York: John Wiley and Sons.
1. Chatfield, C. & Collin, A. J. (1980). *Introduction to multivariate analysis*. New York: Chapman and Hall.
2. Mardia, K.V., Kent, J. T. &Bibby J. M. (1979). *Multivariate analysis*. London: Academic press.

STAT-6313 Research Methods / Internship 3(3+0)

The purpose of introducing a course of research is to inform action. Goal of this course is to seek to contextualize the findings within the larger body of research. This course suggests to produce research that must be of high quality in order to produce knowledge that is applicable outside of the research setting. After learning this course student will be able to understand research terminology, research ethics, and research design and research language. This course aware ethical challenges and approval process. Types of research in broad sense like quantitative, qualitative and mixed method researches are discussed. Suggested course deals with identifying the components of a literature review process and .Critically evaluating previous studies .This course enables a student how to perform and pass the research process by providing them understanding about components of research like Introduction, Literature review, methodology, results and discussion on findings.

Contents

1. Definition of Research.
2. Types of Research
3. Selection of Problem
4. Search of References.
5. Formation of Hypothesis and Procedure for its Testing
6. Research Methodology.
7. Planning of Experiments to Test Hypothesis Objectivity
8. Principals of Experimental Design.
9. Steps in Experimentation,
10. Collection of Data
11. Data Analysis to Determine Functional Relationship Between Variables, Levels of Significance, Interpretation of Results,
12. Components of Scientific Reports.
13. Various Methods of Data Presentation,
14. Preparation of Scientific Reports,
15. Publication Procedures.
16. Survey of Literature on a Given Topic
17. Collection of References from Various Sources Including SD-ROM Data Base.
18. Collection of Primary and Secondary Data,
19. Arrangement of Primary and Secondary Data,
20. Preparation of Scientific Report for Publication, if Possible.

Recommended texts

1. Hashmi, N. (1989).*Research, foundations and methodology*. Islamabad: Western Press. Style Manual of Technical Writings, USAID/NARC
2. Crowther, D. & Lancaster, G. (2012). *Research methods*. London: Routledge.

Suggested Readings

1. Bernard, H. R. & Bernard, H. R. (2013). *Social research methods: Qualitative and quantitative approaches*. England: Sage.
2. Gimbaled, J. & Acuter, W.S. (1988). *MLA handbook for writers of research papers*.America: McGraw the Modern Language Association of America.

STAT-6314 Non- Parametric Methods 3(3+0)

The main aim of this course is to introduce the principles and applications of commonly used nonparametric methods and to compare these methods to their parametric counterparts through simulation studies. The course gives an introduction to non-parametric statistics, starting with a repetition of the difference between the mean and the median and the influence of having data with a skewed distribution. Typical examples of such data within health economics are costs of stay or the length of stay. The course also covers simple non-parametric tests for comparing groups of observations. Prescribed course is concerned with the non-parametric approach instead of using the vast variety of parametric statistics test due to violating the assumption of normality in the data. Course also enlightens the significance of different supplementary tests those have no concern with the distribution of the data (should normally distributed) or central limit approach. This course based on the utilization of non-parametric tests specifically in such situation where fulfillment of assumptions relating to the sample (data) is quite difficult. Another direction of the course indicates the real life applications, problems and their solutions in an applied field of statistics.

Contents

1. Scales of measurements
2. Non-Parametric problems, when to use non-parametric procedures.
3. Parametric versus nonparametric tests
4. Trimmed and Winsorized means
5. One sample tests.
6. Binomial test, sigma test, wilcoxan signed ranks test,
7. Rank sum Test
8. Kolmogrov-smirnov test,
9. Run test
10. Tests for two related samples.
11. Sign test, run test
12. Chi-square test
13. Test for two independent samples: MANN-Whitney test
14. Median test
15. Chi-square test
16. Wald-wolfwitz test
17. Kolmogrov-Smirnov test.
18. Categorical data, association in $r \times c$ Contigency tables,
19. Partition of $\chi 2$, Binomial and Poisson, Homogeneity tests, Log-Linear models

Recommended Texts

1. Gibbons, J. D.&Chakraborti, S. (2011). *Nonparametric statistical inference*. Berlin: Springer.
2. Annette, J. D. (1991). *Introduction to generalized linear models*. London: Chapman and Hall.
3. Anderson, E. B. (1990). *The statistical analysis of categorical data*.New York: Springer-Verlag.

Suggested Readings

1. Conover, W.J. (1984). *Practical non-parametric statistics*. New Jersey: John Willey.
2. Sprent, P. (1984). *Applied non-parametric statistics*. New Jersey: John Willey
3. Fienberg, S. E. (2007). *The analysis of cross-classified categorical data*. Berlin: Springer.

STAT-6315 Population Studies 4(3+1)

Population studies are broadly defined as the scientific study of human populations. This course is an introduction to demography and population studies. Demography concerns itself with the formal (quantitative) analysis of population size, distribution, structure, and change, whereas population studies deals with the sociological determinants (broadly speaking) and consequences of demographic phenomena. Some topics include: Population History, Population Age-Sex Structure, Fertility, Mortality and Population Health, Migration, Explanations of Nuptiality Change and Canadian Nuptiality Trends, Urbanization, Population and Resources, and Population Change and Policy Concerns. The main aim of this course is to report significant advances in methods of population analysis, conceptual and mathematical theories of demographic dynamics and behavior, and the use of these theories and methods to extend scientific knowledge and to inform policy and practice. It also deals with the fertility rates, mortality rates, migration rates and life tables. It provides the necessary skill to evaluate the impact and consequence of population growth on society. It gives the knowledge of population policy and population measures and to impart basic and applied knowledge about Population Studies and its applications in different fields.

Contents

1. The population and housing census Registration of vital events,
2. Demographic surveys Components of population growth, composition of population and vital events.
3. Types and sources of errors General testing procedures
4. Testing the accuracy of age and sex data
5. Fertility and mortality measures
6. Total and general fertility rates.
7. Estimation from incomplete Data Construction of complete and abridged life tables Different types of life tables.
8. Graphs of Ix, qx and ex. Description and uses of life table columns
9. Stationary population models Population estimates and projections Intercensual estimates.
10. Population projections through various methods.
11. Theory of demographic transition Stable and stationary population models, their applications and uses.
12. Malthusian and post Malthusian theories of growth.
13. Consequences of world population growth & population explosion.
14. State of Population in Pakistan.
15. Development of demographic profile in Pakistan Recent demographic parameters.
16. Current and future demographic activities in Pakistan.

Recommended Texts

1. Weinstein, J. &Pillai, V. K. (2001). *Demography: The science of population*. England: Allyn and Bacon.
2. Hinde, A. (2014). *Demographic method* (2nd ed.).London: Routledge.

Suggested Readings

1. United, N. (1998). *World population assessment*. New York: UNFPA.
2. Govt. of Pakistan (1998). *National, provincial and district census reports and other supplementary reports with respect to 1998 census*. Islamabad: PCO.
3. United, N. (1996). *Added years of life in Asia*. Thailand: ESCAP U.N.

STAT- 6316 Statistical Inference –II 3(3+0)

Statistical inference is the process of using data analysis to deduce properties of an underlying distribution of probability. The goal is to use probability theory to make inferences about population parameters of interest. The aim of this course is to provide a strong mathematical and conceptual foundation in the methods of statistical inference, with an emphasis on practical aspects of the interpretation and communication of statistically based conclusions in research. The fundamental principles of statistical inference procedures are confidence interval procedures and hypothesis testing; both are constructed on the sampling distribution. The course deals with testing of hypothesis, distribution free and randomization tests, interval estimation and scalar parameters. The aim of this course is to provide a strong mathematical and conceptual foundation in the methods of statistical inference, with an emphasis on practical aspects of the interpretation and communication of statistically based conclusions in research. Content includes: a review of the key concepts of estimation, and construction of Normal-theory confidence intervals; frequencies theory of estimation including hypothesis tests, methods of inference based on likelihood theory, including use of Fisher and observed information and likelihood ratio and sequential test.

Contents

1. Neyman Pearson Theorem.
2. Most powerful test
3. Uniformly most powerful tests.
4. Test for binomial distribution
5. MPT for poission
6. UMPT for discrete distribution
7. UMPT for continuous distribution
8. Exponential families of distibution
9. Likelihood ratio tests
10. Maximum likelihood
11. Generalized likelihood ration test
12. The sequential probability ratio test
13. Interval estimation and confidence tests.
14. Relation between testing and confidence intervals.
15. Asymptotic testing
16. Estimation
17. Confidence intervals.
18. Optimality criteria, consistency.

Recommended Texts

1. Hogg, R. M. & Craig, A. T. (2019).*Introduction to mathematical statistics* (7th ed.).New York: MacMillan Co.
2. Mood, A. M., Graybill, F. A. &Boes, D.C. (1997). *Introduction to the theory of statistics*.London: McGraw Hill

Suggested Readings

1. Hogg, A.V. (1995). *Probability and statistical inference*. London: McMillan Co.
2. Hirai, A. S. (1973). *Estimation of statistical parameters*. Lahore: IlmiKhana.
3. Staurt, A. &Ord, K. (1994). *Kendall's advanced theory of statistics* (2nd ed.).England: Charles Griffing and Co.

STAT-6317 Project / Research Report 3(3+0)

A research report is a publication that reports on the findings of a research project or alternatively scientific observations on or about a subject. Research reports are produced by many sectors including industry, education, and government and non-government organizations and may be disseminated internally, or made public i.e. published however they are not usually available from booksellers or through standard commercial publishing channels. Research reports are also issued by governmental and international organizations. This is purely designed for students to know how to work on a research project and how to write a report on any topic. As research is a key field in this world so this focuses on different topics assigned to the students. This course is used to establish or confirm facts, reaffirms the results of previous work, solve new or existing problems, support theorems, or develop new theories. This subject is very useful for students because after doing research report they are capable to use their theoretical knowledge in variety of different fields according situation.

Contents

1. Introduction to Research
2. Nature of research
3. Statement of problem
4. Method of data collection
5. Style of literature review
6. Concept of writing methodology
7. Evaluating of data analysis
8. Various method of reference
9. Research paper
10. Presentation of research report
11. Uses of software
12. Allocation of supervisor
13. Student's task related to research

Recommended Texts

1. Different journals
2. Websites

Suggested Readings
Website for data
1. World Bank
2. Index Mundi
3. FAO
4. WHO
5. UNICEF
6. Bureau of Statistics
7. NADRA
8. Agriculture marketing information service
9. The global economy
10. Economic trading
11. Knoema

STAT-6318 Statistical Quality Control 3(3+0)

This course offers applications of the statistical process control techniques that are an integral part of the corporate-wide quality control efforts. The course will discuss the methods of statistical quality control within a broader framework of quality assurance and management. The course will define the various aspects of quality and address the issues of planning for quality as they relate to survey operations and processes. Statistical methods for quality control will be discussed. The uses and applications of various quality tools such as Pareto analysis, cause & effect diagrams, flow charting, etc., for generating quality improvements will also be addressed. This course is mathematical in nature and will contain some theoretical formulas and statistical concepts. The aim of this course is to provide a strong mathematical and conceptual foundation in the methods of statistical quality control, with an emphasis on practical aspects of the interpretation and communication of statistically based conclusions in research. It deals with the construction of control charts for monitoring location and dispersion parameters. This covers the process capability analysis, process improvements using design of experiments and Taguchi method. Acceptance sampling plans along with the different International Standards Organization series are part of the contents.

Contents

1. Statistical quality control
2. Measurement and control of quality.
3. Control charts for $\overline{X}$, R and Sigma,
4. Charts for P, C and U.
5. O.C. curves associated with control charts.
6. Leaf and Stem Plots
7. Box Plot
8. Producer's risk and consumer's risk
9. Process Capability Analysis
10. Acceptance sampling.
11. Single sampling plans
12. Double sampling plans
13. Introduction to multiple sampling plans
14. Robust Charts
15. Intentional quality standards and their certification.
16. Quality management through quality circles, re-engineering etc
17. Case study.

Recommended Texts

1. Montgomery, D. (2013). *Introduction to statistical quality control* (7th ed.). New York: John Wiley & Sons.
2. Juran, J. M. &DeFoe, J.A. (2010). *Juran's quality handbook* (6th ed.).London: McGraw-Hill Education.

Suggested Readings

1. Ryan.T.P. (1989). *Statistical methods for quality improvements*. New York: John Wiley and Sons.
2. Grant, E. l. & Leavenworth, R. S. (2000). *Statistical quality control*. New York: McGraw-Hill Education.

STAT- 6319 Time Series and Forecasting 3(3+0)

Time series analysis has many different objectives, depending on the field of application. These include forecasting future values of the series, extracting a signal hidden in noisy data, discovering the mechanism by which the data are generated, simulating independent realizations of the series to see how it might behave in the future (and hence, for example, to estimate the probability of extreme events like floods), and eliminating the seasonal component from data sets like the one in example 2 in order to reveal more clearly the underlying trend. So to fulfill the main objective of time series analysis the aim of this course is to impart the basic and applied knowledge about Time Series and its applications in different fields with an emphasis on practical aspects of the interpretation of statistically based conclusions in research. It deals with the method of data collection, description measures of data for interpretation of results, model selection, decision making and Forecasting. This course is designed for the modeling and forecasting of time series data. This focuses on the decomposition of time series, stationary data, models for stationary and non-stationary series, forecasting methods and properties of models like mean, variance, auto-covariance and auto-correlation function.

Contents

1. Stochastic Process
2. Stationary time-Series.
3. Auto-correlation and auto-covariance.
4. Estimate functions and standard error of the auto-correlation function (ACF).
5. Spectral Analysis:
6. Periodogram, spectral density functions,
7. Comparison with ACF.
8. Linear stationary models
9. Auto-regressive models
10. Moving average models
11. Mixed models.
12. Non-stationary models,
13. ARMA Models
14. ARIMA models
15. SARIMA models
16. Box-Jenkins Methodology
17. Minimum mean square forecasting.

Recommended Texts

1. Chatfield, C. (1996). *The analysis of time series, an introduction.* London: Chapman and Hall,
2. Cox, D.R., Hinklev, D .V. & Nielsen, O .E. B. (1996). *Time series models in econometrics finances and other fields.* London: Chapman Hall.

Suggested Readings

1. Andy, P., West, M. & Harrison, P .J. (1994*). Applied bayesian forecasting and time series analysis*. New York: Chapman Hall.
2. Harvey, A. C. (1990). *Forecasting structural time series models and the kalman filter*. Cambridge University: Press.
3. Harvey, A.C. (1981). *Econometric analysis of time series*. London: Philip Allan.

STAT- 6320 Official Statistics 3(3+0)

Statistics play a vital role in the economy of a country. Methods and techniques for producing register-based statistics are discussed in depth. Examples of problems addressed are linking, matching, derived variables, missing data and estimation. Models for quality assessment of official statistics are introduced and quality differences between sample-based and register-based statistics are discussed. Here the aspects on reliability and accuracy are of special interest. The aim of the course is to provide the knowledge of officially use of statistics in different fields and organization. This focuses on the methods of data collection, data processing, presentation and publication of statistics. The course is designed for the use of statistics in administration and planning and different organizations like NADRA, State bank of Pakistan, Ministry of finance and bureau of statistics etc. This deals with design and planning of statistical investigation, role of sampling in generation of statistics, role of official statistics and different surveys conducted in Pakistan. Concepts and evaluation of GDP, GNP, balance of trade and payment, measurement of income distribution are also the part of the contents.

Contents

1. Design and planning of a Statistical Investigation. Data collection approach and operation; Role of sampling in generation of statistics. Sampling plans and survey designs.
2. Sources of Errors, types of Errors, methods of their control. Data processing, presentation, and publication of statistics.
3. Different modes of data dissemination. Official statistics, statistics systems and standards, sources of official statistics, their role, working and publication. Role of official statistics, official publications.
4. Setup of official organizations in Pakistan their role, working & publication, statistics division,
5. Federal Bureau of statistics, Agricultural Census Organization, Population Census Organization, Ministry of Food , and Agriculture and Livestock;
6. National Data Bade and Registration Authority (NADRA). Provincial Bureaus of statistics.
7. Financial statistics: Ministry of Finance, state Bank of Pakistan-Department of statistics, their working publications and responsibilities.
8. Other organization's statistical output, National and International series, classification and standards.
9. Use of statistics in administration and planning.
10. Concepts and evaluation of GDP, GNP, NNP, balance of trade and payments.
11. Measurement of income Distribution,
12. Use of index numbers, and time series, Deflation and inflation of series.
13. National sample surveys and censuses conducted in Pakistan.
14. Assignment: Visit of major statistical organizations will be a part of the course.
15. An assignment will have to be submitted on any topic given by the course incharge.

Recommended Texts

4. Kish, L. (1982). *Survey sampling*. New York: John Wiley and Sons.
1. Statistics, D. (2005). *Activity report government of Pakistan*. Islamabad: Statistics division.

Suggested Readings

1. Statistical institute for Asia & Pacific SIAP. (1984). *Training of trainers in statistical operations and procedure*. Part-1, II. Tokyo, UNDP.
2. Murthy, M. N. (1979). *Quality of data, country course on sample survey*, Karachi: Statistics bureau.

STAT-6321 **Bio Statistics** **3(3+0)**

Using the tools of statistics, biostatisticians help answer pressing research questions in medicine, biology and public health, such as whether a new drug works, what causes cancer and other diseases, and how longa person with a certain illness is likely to survive. Biostatisticians use their quantitative skills to team with experts in other fields, from biologists and cancer specialists to surgeons and geneticists. New statistical tools and software are often needed to interpret the massive amounts of data and to detect correlations and causations. The basic aim of this course is to highlight the advance applications of probabilistic approaches in the concern of statistical paradigm. Course explores the importance of risk factors and effective decision making strategies. This course also classified according to their metric requirements (i.e., metric level, commensurability across the dimensions, and lexicographic ordering) in the system, is given. A brief introduction to process tracing techniques is followed by a review of results reported in process tracing studies of decision making.

Contents

1. Definition of Biostatistics, vis-à-vis,
2. The type of variables and observations in biological.
3. Health and medical sciences
4. Uniqueness in terms of behavior of variables their domain, and units.
5. Categorical. Numerical data
6. Censored data.
7. Population, Target populations and samples.
8. Role of sampling in biostatistics
9. Size of samples of various types of studies.
10. Proportions
11. Rates and rations;
12. Incidence, prevalence and odds.
13. Distributional behavior of biological variables (Binomial, Poisson and Normal).
14. Role of transformation for analysis of biological variables.
15. Probit Models
16. Logit transformations and their analysis,
17. P values, its importance and role.
18. Confidence interval
19. Simple and composite hypothesis testing.

Recommenced Texts

1. Zar, J. (2000). *Bio statistical analysis* (5^{th}ed.). New York: John Wiley and Sons.
2. Shoukri, M. M. & Pause, C. C. (1998). *Statistical methods for health sciences* (2^{nd}ed.). Florida: CRC press.

Suggested Readings

1. Daniel, W.W. (1996). *Biostatistics: A foundation for the health sciences*(6^{th}ed.). New York: John Wiley & Sons.
2. Diggle, P., Diggle, P. J., Heagerty, P., Liang, K. Y., Heagerty, P. J. &Zeger, S. (2002). *Analysis of longitudinal data*. Oxford University: Press.
3. Dunn, G. &Everit, B. (1995). *Clinical biostatistics*. London: Edward Arnold.

STAT-6322 Robust Methods 3(3+0)

The aim of this course is to provide a strong mathematical and conceptual foundation of the methods of Robust Statistics with an emphasis on practical aspects of the interpretation and communication of statistically based conclusions in research. Content includes: a review of the key concepts of basic statistics, estimation, and probability. Robust statistics are statistics with good performance for data drawn from a wide range of probability distributions, especially for distributions that are not normal. Robust statistical methods have been developed for many common problems, such as estimating location, scale, and regression parameters. It deals with the construction of objective functions of location and dispersion parameters along with M-estimators, E-estimator, R-estimator and W-estimator. It also discusses the performance measures, such as breakdown point, influence function and gross error sensitivity etc, of the estimators. This covers the M-estimator for scale, outliers and influential observations in regression analysis as well. In computer sessions, robust methods will be applied to real data sets and the results will be interpreted. Some properties of the estimators will be verified empirically, for instance by Monte Carlo simulation.

Contents

1. Introduction to Robustness.
2. Objective function.
3. M-estimator of location.
4. E-estimator and its functions
5. R-estimator and its functions
6. W-estimator. and its functions
7. Re descending M- estimators.
8. The Breakdown point of robust estimator Influence function.
9. M-estimator for scale.
10. Gross error sensitivity
11. Sensitivity Analysis
12. Contaminated normal distribution
13. Comparisons of usual and robust estimators
14. Monte Carlo simulation
15. Evaluation of breakdown point by simulation
16. Outliers and influential observations.
17. Outliers in Regression analysis.

Recommended Texts

1. Maronna, R., Martin, R. &Yohai, V. (2006). *Robust statistics: Theory and methods*. New York: John Wiley & Sons.
2. Rousseau, P. J. & Leroy, A.M. (1987). *Robust regression and outlier detection*. New York: John Wiley & Sons.

Suggested Readings

1. Huber, P. J. (1981). *Robust statistics*. New York: John Wiley & Sons.
2. Stuart, A. &Ord, J .K. (1998*). Kendall's advanced theory of statistics* (1st ed.). London: Charles Griffin.
3. Hamper, T.R., Brochette, E.M., Rousseau, P. J. & Satchel, W. A. (1986). *Robust statistics: The approach based on influence functions*. New York: John Wiley& Sons.

STAT-6323 Operations Research 3(3+0)

Operational research is the application of scientific methods to the study of complex organizational problems. It is concerned with applying advanced analytical methods to make effective decisions in strategic planning or operational planning, and builds more productive systems. This includes all key stages of solving real-world problems.Operational researchers and statisticians play a fundamental role in the modern world. The aim of this course is to fulfill the needs of society in the fields of Statistics and Operations and to understand different application areas of operations research like transportation problem, assignment model, sequencing models, dynamic programming, game theory, replacement models & inventory models. This is designed to impart basic and applied knowledge about Operation Research and its applications in different fields of marketing. This program is an ideal opportunity to provide your-self with the analytical and statistical skill set necessary for success in industry, business or in the public sector. Course also enlightens the significance of mathematical modeling based strategies based on both mathematical and applied nature of disciplines. The program for Operational Research and Statistics provides students with the ideal skill set in mathematical modeling, experimental design, statistical analysis, and numerical computation.

Contents

1. Historical study of operation research
2. Linear Programming.
3. Methods to solve LP models
4. Graphical Methods
5. Mathematical computations
6. The simplex methods.
7. Degeneracy and cycling
8. Artificial variables
9. Duality
10. The dual simplex method,
11. Sensitivity analysis.
12. Transportation
13. Methods of solving transportation
14. Assignment problems
15. Game theory
16. Problems of game theory
17. Network analysis
18. Queuing theory.

Recommended Texts

1. Taha, H.A. (2017).*Operation research, an introduction* (10th ed.).London: Pearson.
2. Bhatti, S.A. &Bhatti, N. A. (1998). *Operation research, An Introduction*. Lahore: A-one publishers.

Suggested Readings

1. Gupta, P. K. &Hira, D.S. (1994).*Operation research*. New Delhi: S. Chand and Co.
2. Hillier, F. & Lieberman, G. (1992). *Introduction to operation research*. England: Holden Day.
3. Sposity, V. A. (1985). *Linear programming with statistical applications*. Lowa State: University Press.

STAT-6324 Mathematical Modeling and Simulation 3(3+0)

Mathematical modelling and simulation are important research and monitoring tools used to understand biological communities and their relationships to the environment. The field of advanced simulation contains powerful tools and techniques to study stochastic models and other objects which defy a direct mathematical analysis. Mathematical models are collection of variables, equation, and starting values that form a cohesive representation of a process or behavior. Simulation is the process of using a model to study the behavior and performance of an actual or theoretical system. This course introduces some statistical modeling simulation methods to evaluate the performance of statistical methods. This course emphasizes both the theoretical and practical aspects of statistical simulation and analysis. It deals with the different methods of generating random numbers and random variables. It focuses on acceptance and rejection techniques from various distributions. Variance reduction techniques and resampling techniques are also the part of the course.

Contents

1. Different methods of generating random numbers
2. Generation of random variables.
3. Acceptance techniques from various distributions
4. Rejection techniques from various distributions.
5. Comparison of algorithms to generate random variables,
6. generating random variables from failure rates
7. Generation from multinomial distribution
8. Monte Carlo integration
9. Monte Carlo simulation
10. Gibbs sampling and other resampling techniques
11. Variance reduction techniques:
12. importance sampling for integration
13. Control variates
14. Regression analysis
15. Testing of hypothesis
16. Control charts through simulation
17. Time Series Models in R
18. Antithetic variables.

Recommended Texts

1. Ross, S.M. (2002). *Simulation*(3rd ed.). London: Academic Press.
2. Crawley, M.J. (2012). *The R book* (3rded.). London: John Wiley& Sons.

Suggested Readings

1. Velten, K. (2009). *Mathematical modeling and simulation*. New York: John Wiley& Sons.
2. Vasishth, S. & Bore, M. (2010). *The foundations of statistics: A Simulation-based approach*. New York: Springer.

STAT-6325 Numerical Methods 3(3+0)

Numerical methods are the fast solution for mathematical problems. Numerical methods are algorithms used for computing numeric data. They are used to provide 'approximate' results for the problems being dealt with and their necessity is felt when it becomes impossible or extremely difficult to solve a given problem analytically. Methods such as finite difference method (FDM), finite volume method (FVM), finite element method (FEM), boundary element method (BEM) etc are commonly used for treating PDE numerically. All numerical methods used to solve PDEs should have *consistency, stability* and *convergence*. Statistics and data analysis are an essential part of a modern engineer's toolkit. So are numerical methods for solving a variety of mathematical problems. This course is designed to enhance the problem solving skills of students using an extremely powerful problem solving tool namely numerical methods. The tool is capable of handling large system of equations, nonlinearities and complicated geometries that are common in practice and that are often impossible to solve analytically. This also focuses on numerical Differentiation, Integration and numerical solutions of ordinary and partial differential equation.

Content

1. Approximation and Errors in computing: Introduction,
2. Significant digits, Inherent error, Rounding error,
3. Truncation error, Absolute and relative error, Error propagation.
4. Roots of Non Linear Equations and solution of system of Linear Equations: Bisection method,
5. False position Method, Newton-Raphson Method
6. Difference Operators & Interpolation: Forward and Backward difference operators and table, Interpolation with equidistant point,
7. Lagrange Interpolation Polynomial, Newton Interpolating Polynomial using divided Difference Table
8. Numerical Differentiation and Integration: Differentiating continuous functions, differentiating tabulated functions,
9. Higher order derivatives,
10. Richardson's Extrapolation, Newton – cotes integration formula,
11. Trapezoidal rule, Simpson's rule, Boole's rule and Weddle's rule, Romberg's Integration
12. Numerical Solution of Ordinary and Partial Differential Equations
13. Taylor series method,
14. Euler and modified Euler method

Recommended Texts

1. Grewal, B. S. (2014). *Numerical methods in engineering and science* (9th ed.). India: Khanna Publication.
2. Jain, M. K., Iyengar, S. R. K. & Jain, R.K. (2007). *Numerical methods for scientific and engineering computation* (5th ed.). Germany: New age International Publishers.

Suggested Readings

1. Curtis, F. G. & Patrick, O. W. (2007). *Applied numerical analysis* (7th ed.). London: Pearson Education.
2. Balagurusamy, E. (1999). *Numerical method* (1st ed.). England: Tata McGraw Hill Publication.

STAT-6326 Categorical Data Analysis 3(3+0)

This course is designed to introduce basic concepts and common statistical models and analyses for categorical data; to provide enough theory, examples of applications in a variety of disciplines (especially in social and behavioral science); and practice using categorical techniques and computer software so that students can use these methods in their own research; to attain knowledge necessary to critically read research papers that use such methods. This course deals with the most fundamental regression models for binary, ordinal, nominal and count outcomes. While advances in software make it simple to estimate these models, post-estimation interpretation is difficult due to the nonlinearity of the models. Prescribed course is concerned with the applicable knowledge about statistics in the field of categorical nature of variables. Course is aimed at providing students with a formal treatment of categorical data specifically in the social sciences and decision making theories based on behavioral and attritional variables. This course also explores the basic concepts of advanced categorical methodologies with their mathematical derivations. Course communicates the high skills to play the major role in statistics by using the knowledge of categorical data. The course is heavily oriented with tools for analyzing categorical data with practical applications.

Contents

1. Introduction,
2. Describing two way contingency tables.
3. Chi-Square test
4. Models for binary response variables,
5. log linear models
6. Fitting log linear
7. logit models
8. Probit models
9. Building and applying log linear models,
10. Log linear logit models for ordinal variables.
11. Multinomial response models for matched pairs.
12. Analyzing repeated categorical response data.
13. Logistic regression models and their analysis.
14. Practical application
15. Practical works on software

Recommended texts

1. Agresti, A. (1999). *Categorical data analysis*. London: John Wiley and Sons.
2. Bishop, Y. V. V., Fienberg, S. E. & Holland, P. W. (1975). *Discrete multivariate analysis*. Cambridge: MIT Press.

Suggested Readings

1. Cox, D. R. & Snell, E. J. (1989). *The analysis of binary data*. London: Chapman and Hall.
2. Kleinbaum, D. G., Dietz, K., Gail, M., Klein, M. & Klein, M. (2002). *Logistic regression*. New York: Springer-Verlag.
3. Hosmer, D. W., Lemeshow, S. &Sturdivant, R. X. (2013). *Applied logistic regression*. New York: John Wiley and Sons.

STAT-6327 **Stochastic Process** **3(3+0)**

Stochastic processes are the natural tool to model real-world phenomena involving randomness and uncertainty. They offer a power mathematical framework to analyze complex problems in a variety of applied areas, ranging from business and industry to economics, finance, social sciences, and biology and computer science. Moreover, the use of stochastic processes (and related probabilistic techniques) to build advanced statistical models is central to the ongoing data science revolution. The aim of the course is to provide students with a basic understanding of the probabilistic models and techniques underlying the most widely used classes of stochastic processes. The purpose of this course is to equip students with theoretical knowledge and practical skills, which are necessary for the analysis of stochastic dynamical systems in economics, engineering and other fields. More precisely, the objectives are, study of the basic concepts of the theory of stochastic processes; introduction of the most important types of stochastic processes; study of various properties and characteristics of processes; study of the methods for describing and analyzing complex stochastic models.The objective of the course is to provide the applicable knowledge about stochastic process, generating functions, difference equation, Laplace transforms, random walk and Markov chains. It covers the pure birth and death process, Markov process with discrete and continuous state space, expected duration of the game and classical gambler's ruin problem. The Wiener process is also the part of the course.

Contents

1. Introduction. Generating Functions.
2. Laplace Transforms. Difference equations.
3. Differential - difference equations.
4. Introduction to Stochastic Processes.
5. The Random Walk in one and two dimensions.
6. The Classical Gambler's Ruin Problem.
7. Expected Duration of the Game.
8. Markov Chains: Definition. Higher Transition Probabilities. Classification of States and Chains.
9. Markov Processes with Discrete State Space. Poisson Process and its Generalization.
10. Pure Birth and Death Processes.
11. Markov Process with Discrete State Space (Continuous Time Markov Chains).
12. Markov Processes with Continuous State Space.
13. Introduction to Brownian Motion.
14. The Wiener Process. Diffusion Equations for the Wiener Process.

Recommended Texts

1. Ross, S. (1996). *Stochastic process* (2nd ed.). New York: John Wiley and Sons.
2. Feller, W. (1992). *An introduction to probability theory and its applications.* New York: John Wiley and Sons.

Suggested Readings

1. Srinivasin, S. K. & Mehta, K.M. (1988). *Stochastic processes*. England: Tata McGraw Hill.
2. Karlin, S. A. & Taylor, H. M. (1984). *A first course in stochastic process*. London: Academic Press.

STAT-6328 **Reliability Analysis** **3(3+0)**

Reliability refers to the extent to which a scale produces consistent results, if the measurements are repeated a number of times. It refers to the fact that a scale should consistently reflect the construct it is measuring. An aspect in which the researcher can use reliability analysis is when two observations under study that is equivalent to each other in terms of the construct being measured also have the equivalent outcome. Reliability in statistics is the overall consistency of a measure. A measure is said to have a high reliability if it produces similar results under consistence conditions. Score that is highly reliable is precise, reproducible, and consistence from one testing occasion to another. Reliability analysis allows to study the properties of measurement scales and the items that compose the scales. The aim of this course is to develop the basic concepts of reliability. It discusses the concepts of structural reliability. This covers lifetime distributions, gamma, Weibull, log normal, inverse Gaussian distribution and estimation. Testing reliability hypothesis, system reliability, failure models, inferences of these models and accelerated life testing are parts of the contents.

Contents

1. Basic concepts of reliability.
2. Structural reliability.
3. Lifetime distributions (Failure Models):
4. Hazard rate;
5. Gamma,
6. Weibill, Gumball,
7. Log-Normal
8. Inverse Gaussian Distribution.
9. Stochastic fatigue rate models.
10. Point and Interval estimation.
11. Fatigue life model.
12. Testing reliability hypothesis.
13. Monte-Carlo, Distribution free and
14. Baye's method in reliability.
15. nSystem reliability;
16. Series and parallel systems.
17. Failure Models,
18. (k-out-of-m)
19. New-better-than used models.
20. Inferences for these models.
21. Accelerated life testing.

Recommended Texts

1. Haldar, A. &Mahadevan, S. (2000). *Reliability assessment using stochastic finite element analysis*. New York: John Wiley and Sons.
2. Crowder, M. J., Kimber, A., Sweeting, T. & Smith, R. (1994). *Statistical analysis of reliability data*. Germany: CRC Press.

Suggested Readings

1. Bryson, M. C. (1992). *Statistical analysis of reliability and life-testing models*. Germany: CRC Press
2. Gertsbakh, I.B. (1989). *Statistical reliability theory*. New York: Marcel Decker.

STAT-6329 **Survival Analysis** **3(3+0)**

Statistics for analyzing the expected duration of time until one or more events happen. Survival analysis is used to estimate the lifespan of a particular population under study. The goal is to estimate the time for an individual or a group of individuals to experience an event of interest. This time estimate is the duration between birth and death events. A survival analysis can be used to determine not only the probability of failure of manufacturing equipment based on the hours of operations, but also to differentiate between different operating conditions. This course is designed for special features of survival data, survival functions and hazard function. It deals with time dependent data, non-parametric procedures, estimation of survival function, median and percentile of survival time, stratified and long rank test for trend. It provides knowledge about modelling of survival data, exploratory data analysis and the use of computer software for survival analysis. Main objectives of the course are, to identify characteristics of survival data and their implications for analysis, to Perform and interpret univariate analyses of survival data, to compare groups using common statistical procedures, to analyze survival data and interpret results.

Contents

1. Special features of survival data:
2. Patient time and study time,
3. Survival function
4. Hazard function,
5. Time dependent
6. Censored survival data.
7. Nonparametric procedures:
8. Estimation of survival function, hazard function,
9. Median and percentiles of survival times.
10. Confidence interval and comparison of group
11. Stratified and log-rank test for trend.
12. Modeling of survival data;
13. Hazard function modeling;
14. Tests and confidence interval.
15. The waybill model for survival data.
16. Exploratory data analysis and other models.
17. Sample size requirement for survival study.
18. Computer software for survival analysis; any available software
19. SAS, BMDP, SPSS, GLIM, GENSTAT or S-plus.

Recommended texts

1. Lee, E.T. (1997). *Applied survival analysis*. New York: John Wiley and Sons.
2. Muller, R.G. & Zhou, X. (1996). *Survival analysis with long-term survivors.* New York: John Wiley and Sons.

Suggested Readings

1. Burkett, M. (1995). *Analyzing survival data from clinical trials and observational studies*. New York: John Wiley and Sons.
2. Cox, D. R. & Oakes, D. (1984). *Analysis of survival data*. London: Chapman & Hall.

STAT-6330 Actuarial Statistics-I 3(3+0)

This course covers survival models and their estimation as well as applications in insurance and finance. Specific topics include: the concept of survival models and actuarial notation; estimation of lifetime distributions; multiple state models; maximum likelihood estimation of transition intensities; the binomial model of mortality and its estimation; models with transition intensities depending on age and duration; the census approximation and formulae; statistical comparison of crude rates with a standard table; graduation of crude estimates and tests of fidelity and smoothness; analysis of mortality/morbidity and the main forms of selection; models for projection of mortality. This deals with Utility theory, insurance and utility theory, models for individual claims and their sums, survival function, curate future lifetime, force of mortality. It provides Life table and its relation with survival function, examples, assumptions for fractional ages, some analytical laws of mortality, select and ultimate tables. To developing multiple life functions, joint life and last survivor status, insurance and annuity benefits through multiple life functions evaluation for special mortality laws suggested course is helpful. Multiple decrement models, deterministic and random survivorship groups, associated single decrement tables, central rates of multiple decrement, net single premiums and their numerical evaluations.

Contents

1. Utility theory, insurance and utility theory
2. Models for individual claims and their sums,
3. Survival function, curate future lifetime, force of mortality.
4. Life table and its relation with survival function, examples,
5. Assumptions for fractional ages
6. Some analytical laws of mortality, select and ultimate tables.
7. Multiple life functions, joint life and last survivor status,
8. Insurance and annuity benefits through multiple lives function evaluation for special mortality laws.
9. Multiple decrement models,
10. Deterministic and random survivorship groups, associated single decrement tables, central tables of multiple decrement, net single premiums and their numerical evaluations.
11. Distribution aggregate claims,
12. Compound Poisson distribution and its applications.

Recommended Texts

1. Klein, J. P. &Moeschberger, M. L. (2003). *Survival analysis: techniques for censored and truncated data.* New York: Springer.
2. Bowers, N.L Gerber, H. U. Hickman, J.C. Jones, D.A. & Nesbitt, C.J. (1987). *Actuarial mathematic*. USA: Society of Actuarial, Ithaca.

Suggested Readings

1. Blackwell, D. & Graphic, M. A. (1966). *Theory of games and statistical decision*. New York: John Wiley and Sons.
2. Pitacco, E., Denuit, M., Haberman, S. &Olivieri, A. (2009).*Modelling longevity dynamics for pensions and annuity business*. Oxford University Press.
3. Neill, A. (1977). *Life contingencies*. Heinemann: Heinemann for the Institute of Actuaries and the Faculty of Actuaries.

STAT-6331 Bayesian Statistics 3(3+0)

The main objective of this course is to provide a strong mathematical and conceptual foundation in the methods of Bayesian statistics, with an emphasis on practical aspects of the interpretation and communication of statistically based conclusions in research. Bayesian methods which allow for inclusion of relevant problem-specific knowledge in to the formation of one's statistical model.Bayesian statistical methods start with existing prior beliefs, and update these using data to give posterior beliefs, which may be used as the basis for inferential decisions. Bayesian procedures are concerned with the best estimating a value or range of values for a particular population parameter. It deals with the estimation of parameters in a different approach. Bayesian statistics are a system for describing epistemological uncertainty using the mathematical language of probability. Bayesian analysis, a method of statistical inference that allows one to combine prior information about a population parameter with evidence from information contained in a sample to guide the statistical inference process. It also discusses the parameter estimation of different probability distributions and their efficiency. Prior distribution, formulation of posterior distribution and predictive distribution estimation is part of the content. In Bayesian statistics, the key operations areto implement Bayes' theorem and then to derive relevant inferences or decisions from the posterior distribution.

Contents

1. Introduction to Bayesian Statistics
2. Prior information
3. Prior distributions
4. Likelihood Function
5. Methods of elicitation of prior distributions
6. Posterior distributions
7. The posterior means, median and mode
8. Loss Functions
9. Bayes estimators under loss functions
10. Variances of univariate posterior distributions
11. Variances of bivariate posterior distributions
12. Noninformative priors
13. Methods of elicitation of noninformative priors
14. Bayesian Hypothesis Testing:
15. Bayes factor
16. The highest density region
17. Posterior probability of the hypothesis.

Recommended Texts

1. Bolstad, W. M. & Curran, J. M. (2016). *Introduction to bayesianstatistics.*New York: John Wiley and Sons.
2. Berger, J. O. (2013). *Statistical decision theory and bayesiananalysis.*London: Springer Science and Business Media.

Suggested Readings

1. DeGroot, M. H. (2005). *Optimal statistical decisions*. New York: John Wiley and Sons.
2. Ferguson, T. S. (2014). *Mathematical statistics: A decision theoretic approach*. London: Academicpress.
3. Carlin, B. P. & Louis, T. A. (2008). *Bayesian methods for data analysis*. England: CRC Press.

STAT-6332 **Decision Theory** **3(3+0)**

Decision theory is an interdisciplinary approach to arrive at the decisions that are the most advantageous given an uncertain environment. Decision theory brings together psychology, statistics, philosophy, and mathematics to analyze the decision making process. Decision theory is closely related to game theory and is studied within the context of understanding the activities and decisions underpinning activities such as auctions, evolution, and marketing. Descriptive, prescriptive, and normative are three main areas of decision theory and each studies a different type of decision making. Descriptive decision theory: examines how irrational beings make decisions. Prescriptive decision theory: tries to provide guidelines for agents to make the best possible decisions given an uncertain decision-making framework. Normative decision theory: provides guidance for making decisions given a set of values. Decision theory framework generally identifies three types of decision classes: Decisions under certainty: an abundance of information leads to an obvious decision. Decisions under uncertainty: analysis of known and unknown variables lead to the best probabilistic decision. Decisions under conflict: a reactive approach that involves anticipating potential consequences to the decision, prior to making a decision. The basic aim of this course is to highlight the advance applications of probabilistic approaches in the concern of statistical paradigm. Course explores the importance of risk factors and effective decision making strategies. This course also classified according to their metric requirements (i.e., metric level, commensurability across the dimensions, and lexicographic ordering) in the system, is given. A brief introduction to process tracing techniques is followed by a review of results reported in process tracing studies of decision making.

Contents

1. The nature and concept of loss functions, parameters,
2. Decisions and sample spaces.
3. Risk loss
4. Average loss, Admissibility and the class of admissible decisions.
5. Minimax principle and its application to simple decision problems.
6. Linear and quadratic losses and their uses in problems of estimation and testing hypotheses.
7. Asymptotically minimax procedure,
8. A prior distributions and conjugate priors.
9. Bayes' decision procedure,
10. Admissibility of Bayes; Maxmin procedures.

Recommended Texts

1. Anderson E.B. (1990). *The statistical analysis of categorical data.*London: Springer.
2. Berger, J. O. (1985). *Statistical decision theory and bayesian analysis.* London:Springer.

Suggested Readings

1. Blackwell, D., & Graphic, M. A. (1966). *Theory of games and statistical decision*. New York: John Wiley and Sons.
2. Bowers, N. L. Gerber, H. U. Hickman, J. C. Jones, D. A. & Nesbitt, C. J. (1997). *Actuarial mathematics*. USA: Society of Actuaries, Ithaca.

STAT-6333 **Data Mining** **3(3+0)**

Data mining is defined as the practice of examining large pre-existing databases in order to generate new information. It is the process used to extract usable data from a larger set of raw data. It implies analyzing data patterns in large batches of data using one or more software. Data mining involves effective data collection and warehousing as well as computer processing. Data mining is a process used by companies to turn raw data into useful information. By using software to look for patterns in large batches of data, businesses can learn more about their customers to develop more effective marketing strategies, increase sales and decrease cost. Statistics are a component of data mining that provides the tools and analytical techniques for dealing with large amounts of data. It is the science of learning from data and includes everything from collecting and organizing to analyze and presenting data. This course focuses on the concepts of database including simple and relational database, data warehouses, classification and decision trees and clustering method from data mining viewpoints. It also involves dimension reduction and feature selection, artificial neural networks and regression tress. This course deals with the association rules and prediction.

Contents

1. Introduction to databases,
2. Simple database
3. Relational databases
4. Data warehouses.
5. Review of classification methods from multivariate analysis
6. Classification and decision trees.
7. Clustering methods from both statistical
8. Data mining viewpoints
9. Vector quantization.
10. Unsupervised learning from univariate and
11. Multivariate data
12. Dimension reduction and feature selection.
13. Supervised learning from moderate to high dimensional input spaces
14. Artificial neural networks
15. Extensions of regression models,
16. Regression trees.
17. Association rules and prediction;
18. Applications to electronic commerce.

Recommended texts

1. Han, J.& Camber, M. (2000). *Data mining, concepts and techniques*. London: Morgan Gaufman.
2. Benson, & Smith, S.J. (1997). *Data warehousing, data mining, and OLAP*. New York: McGraw-Hill.

Suggested Readings

1. Mitchell, T. M. (1997). *Machine learning*. London: McGraw-Hill.
2. Ripley. (1996). *Pattern recognition and neural networks*. Cambridge University: Press

STAT-6334 Actuarial statistics-II 3(3+0)

Statistics are all about processing data and extracting information. The information we seek is the parameters and distribution of the random variable that generated the data. Armed with this information we can answer questions about reality and optimize industrial processes. Statistics thus form the backbone of science and business and this course is designed to help you understand the components of this fundamental subject and how they all fit together. So Actuarial Statisticsare a general term for the data used by actuaries in evaluating the risks of morbidity and mortality in partc ular groups, and projecting future financial liabilities of insurance policies and pensions. This course is designed for advance understanding of actuarial science in applied nature. How does it works with real life mechanism, this course is capable to answer. This course consist of Principles of compound interest: nominal and effective rates of interest and discount, continuous compounding. After studying this course student will be able to understand Life Insurance process, insurance payable at the moment of death and at the end of the year of death-level benefit insurance, recursions, commutation functions. Life annuities: a single payment, continuous life annuities, and complete annuities-immediate and apportion able annuities-due. Net premiums: continuous and discrete premiums.

Contents

1. Principles of compound interest: National and effective rated of interest and discount,
2. Force of interest and discount, compound interest accumulation factor, continuous compounding. Life insurance: Insurance payable at the moment of death and at the end of the year of death-level benefit insurance, endowment insurance,
3. Deferred insurance and varying benefit insurance, recursions, commutation functions.
4. Life annuities: Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions varying annuities, recursions, complete annuities-immediate and apportionable annuities-due.
5. Net premiums, Continuous and discrete premiums, true monthly payment premiums, apportionable premiums, commutation functions accumulation type benefits. Payment premiums, apportionable premiums, commutation functions.
6. Net premium reserves: Continuous and discrete net premium reserve, reserves on a semi-continuous basis, reserves based on true monthly premiums, reserves on a apportionable of discounted continuous basis,
7. Reserves at fractional durations, allocations of loss to policy years, recursive formulas and differential equations for reserves, commutation functions.
8. Some practical considerations: Premiums that include expenses-general expenses types of expenses, per policy expenses.Claim amount distributions: Approximating the individual model, stop-less insurance.

Recommended Texts

1. Bowers, N.L. Gerber, H. U. Hickman, J. C. Jones, D. A. & Nesbitt, C.J. (1997). *Actuarial mathematics(*2nd ed.). USA: Society of Actuaries.
2. Spurgeon, E.T. (1972). *Life contingencies.* Cambridge University Press.

Suggested Readings

1. Neill, A. (1977). *Life contingencies*. Heinemann:Routlegde.
2. Blackwell, D. & Graphic, M. A. (1966). *Theory of games and statistical decision*. New York: John Wiley & Sons.