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高等数理统计

一 基本信息

开课学院（系）和学科：理学院 数学系

课程代码：X071574

课程名称：高等数理统计

学时/学分：48 学时/3 学分

开课学期：秋季

预修课程： 概率论与数理统计

课程主要内容： 统计基本知识、点估计、假设检验、区间估计、非参数统计推断和 Bayes 统计推断与决策

适应专业学科： 数学系统计学硕士和博士学位研究生

教材/教学参考书：

【1】范金城，吴可法， 《统计推断导引》，科学出版社，2001

【2】茆诗松、王静龙、 濮晓龙，《高等数理统计》(第二版)， 高等教育出版社和施普林格出版社，2006

【3】G. Casella, R.L. Berger, Statistical inference (Second Edition), DUXBURY THOMSON LEARNING, 2002

二 课程简介

高等数理统计是数理统计学的核心基础内容，它重点研究如何有效合理地收集、处理带随机性数据并做出科学决策的理论依据。本课程系统地介绍统计推断的基本理论和方法，包括参数点估计，参数假设检验，区间估计，非参数统计推断、Bayes 统计推断与决策等。本课程是在本科《数理统计》基础上的升华，是统计学硕士和博士研究生的主要学位课程。本课程的学习要求学生牢固掌握统计推断的基本理论和方法，培养他们运用统计推断方法分析数据和解决有关实际问题的能力。

三 教学大纲

1 统计基本知识概述

内容:总体,个体,样本,样本观测值,样本容量,简单随机样本,统计量;抽样分布；次序统计量的分布；常用统计分布族；充分统计量的概念和判别；指数型分布族

及充分统计量。

2 参数点估计

内容:点估计方法；矩估计法；极大似然估计法；点估计的优良标准:⑴无偏性；（2）有效性；（3）相合性；（4）均方误差准则；（5）充分性；（6）完备性。参数无偏估计的 C－R 下界。最小方差无偏估计(MVUE)。

3 参数假设检验

内容：假设检验的概念；假设检验的分类:参数假设检验和非参数假设检验；原假设和备选假设；检验统计量和临界值；拒绝域和检验函数；两类错误。似然比检验，似然比检验的优良性；一致最大功效检验。多参数指数族及正态分布参数的假设检验。

4 区间估计

内容：区间估计的概念；区间估计的方法：（1）找枢轴量法；（2）利用假设检验法；（3）一般方法；（4）信任区间法；（5）一致最精确（UMA）区间估计。

5 非参数统计推断

内容：估计的非参数方法：次序统计量的充分完备性；U 统计量；经验分布函数。非参数假设检验方法：符号检验法；秩和检验法；Pearson 检验法。稳健统计简介。

6 Bayes 统计推断

内容：先验分布和后验分布；选取先验分布的方法：Bayes 假设法；共轭先验分布法；不变先验分布法；Jeffreys 方法；最大熵法。参数的 Bayes 点估计：最大后验估计；条件期望估计；参数的 Bayes 区间估计和假设检验。

7Bayes 统计决策

内容：统计决策模型；Bayes 统计决策：Bayes 解；点估计的 Bayes 解；区间估计的 Bayes 解；假设检验的 Bayes 解。多决策问题的 Bayes 解。

Advanced Mathematical Statistics

ⅠCourse Description

<< Advanced Mathematical Statistics>> is the core of mathematical statistics, and its task is to study the theoretical principles about how to efficiently collect and deal with the random data for scientific decision-making. This course systematically introduces the fundamental theories and methods of statistical inference and decision, including point estimation, hypothesis testing, interval estimation, nonparametric statistical inference, Bayesian statistical inference and decision. This course is a distillation of the undergraduate course "mathematical statistics", and it is also an important fundamental course for the postgraduate students major in Statistics.

IIContents

1 Preliminary

Content： Samples and the sample distributions; Statistics and sampling distributions; Distributions of order statistics; Common families of distributions； Sufficient statistics; Exponential families.

2 Point estimation

Content: Methods of finding estimators, method of moments, maximum likelihood estimator; Methods of evaluating estimators, (1) unbiasedness, (2) efficiency, (3) consistency, (4) mean squared error, (5) sufficiency, (6) completeness； Cramer-Rao lower bound of unbiased estimators;The uniformly minimum variance unbiased estimator (UMVUE).

3 Hypothesis testing

Content: Preliminary; Classification of hypothesis testing: parametric and nonparametric hypothesis testing; Null hypothesis and alternative hypothesis; Test statistics and critical value; Rejection region and test function; Two types of errors; Likelihood ratio test; Neyman-Pearson lemma; Uniformly most powerful test;

Hypothesis testing for multi-parameter exponential family and the parameters of normal distribution..

4 Interval estimation

Content: Preliminary; method for finding the interval estimator: (1) method of finding pivotal quantities, (2) method of inverting a test statistic, (3) general method, (4) method of Neyman confidence interval, (5) the uniformly most accurate (UMA) confidence interval.

5 Nonparametric statistical inference

Content: Nonparametric estimation methods; Sufficiency and completeness of order statistics; U statistics; Empirical distribution function; Methods of nonparametric hypothesis testing; Signed test; Rank sum test; Pearson test; Briefly introduction to robust statistics.

6 Bayesian statistical inference

Content: Prior distribution and posterior distribution; Methods of selecting prior distribution; Methods of Bayesian hypothesis; Methods of conjugate prior distribution; Jeffreys methods; Maximum entropy method; Bayesian point estimation for parameters; Maximum posterior estimation; Estimating conditional expectation; Bayesian interval estimation and Bayesian hypothesis testing for parameters.

7 Bayesian Statistical Decision

Content: Statistical decision model; Bayesian statistical decision: Bayesian solution; Bayesian solution of the point estimation; Bayesian solution of the interval estimation; Bayesian solution of hypothesis test; Bayesian solution for multiple decision problem.

贝叶斯统计

一 基本信息

开课学院（系）和学科：理学院 数学系

课程代码：F071604

课程名称：贝叶斯统计

学时/学分：48 学时/3 学分

开课学期：春季

预修课程：概率论与数理统计

课程主要内容：线性回归模型，一般方差分量模型、广义线性模型、面板数据模型

适应专业学科： 数学系统计学、应用统计专业硕士学位研究生选修课

教材/教学参考书：

【1】Ghosh, J. K., Delampady, M., & Samanta, T. (Eds.). An introduction to Bayesian analysis: theory and methods. Springer, 2006.

【2】茆诗松 汤银才 贝叶斯统计 中国统计出版社, 2012.

【3】Berger, James O. Statistical decision theory and Bayesian analysis. Springer, 1985.

【4】Lee, Peter M. Bayesian statistics: an introduction. John Wiley & Sons, 2012.

二 课程简介

本课程是数学系统计学科硕士、博士研究生和应用统计专业硕士学位研究生的选修课。

本课程主要讲解贝叶斯推断与决策理论，贝叶斯先验选择和稳定性，贝叶斯思想在假设检验和模型选择中的体现以及贝叶斯方法在高维问题中的应用，贝叶斯计算等。课程的学习

使得学生对贝叶斯统计分析的基本思想和理论，基本方法、计算以及其应用有比较全面的了解，并能运用贝叶斯统计分析思想和方法分析各种实际数据，并能借助相应的统计软件分析和解决实际问题。

三 教学大纲

1 基本知识

1.l 常见参数模型
1.2 似然函数
1.3 充分统计量和辅助统计量
1.4 经典统计推断中的三个基本问题

2 贝叶斯推断与决策理论

2.l 贝叶斯推断
2.2 贝叶斯决策理论
2.3 贝叶斯推断中的常见问题

3 效用、先验和贝叶斯稳定性

3.l 效用、先验和理性推断
3.2 贝叶斯方法的核心元素
3.3 利用主观先验的贝叶斯分析
3.4 稳定性和敏感性
3.5 先验的种类
3.6 后验分布的稳定性分析

4 大样本方法

4.l 后验分布的极限
4.2 后验分布的渐进展开
4.3 拉普拉斯逼近

5 对低维参数的先验的选择

5.l 构造客观先验分布的方法
5.2 可交换性
5.3 先验分布中的超参数

6 假设检验和模型选择

6.l 贝叶斯因子和后验概率的界

6.2 贝叶斯 p 值
6.3 稳定的贝叶斯异常值检测方法
6.4 客观的贝叶斯因子

7 贝叶斯计算

7.l 逼近
7.2e-m 算法
7.3 蒙特卡洛抽样
7.4 马氏链蒙特卡洛方法

8 高维问题

8.l 参数型的经验贝叶斯
8.2 针对高维参数的线型模型
8.3 高维中的多重假设检验
8.4 高维中的估计和预测

Bayesian Statistics

I Course Description

<< Bayesian Statistics >> is an elective statistical course, which is intended for postgraduate students who major in statistics and applied statistics. This course introduces the fundamental theories of Bayesian statistical analysis and its applications. It mainly covers Bayesian inference and decision theory，the choice of Bayesian prior and Bayesian robustness，Bayesian statistics in hypothesis testing and model selection，the application of Bayesian analysis in high-dimensional problems，Bayesian computation，etc. The object of this course enables the students to grasp the fundamental ideas, theories and methods of Bayesian Statistics and to apply these approaches the statistical software to analyze and solve relative practical problems.

II Contents

1 Preliminaries

1.1 common parametric models
1.2 Likelihood function
1.3 sufficient statistics and ancillary statistics
1.4 three basic problems of inference in classical statistics

2 Bayesian inference and decision theory

2.1 Bayesian inference
2.2 Bayesian decision theory
2.3 Common problems of Bayesian inference

3 Utility，prior，and Bayesian robustness

3.1 utility，prior，and rationa1 preference
3.2 rationality axioms leading to the Bayesian approach
3.3 Bayesian analysis with subjective prior
3.4 robustness and sensitivity
3.5 classes of priors

3.6 posterior robustness

4 Large sample methods

4.1 limit of posterior distribution
4.2 asymptotic expansion of posterior distribution
4.3 Laplace approximation

5 Choice of priors for low-dimensiona1.parameters

5.1 different methods of construction of objective priors
5.2 exchangeability
5.3 hyperparameters for prior

6 Hypothesis testing and mode1.selection

6.1 bounds on Bayes factors and posterior probabilities
6.2 Bayesian p-value
6.3 robust Bayesian outlier detection
6.4 nonsubjective Bayes factors

7 Bayesian computations

7.1 analytic approximation
7.2 the e-m algorithm
7.3 Monte Carlo sampling
7.4 Markov chain Monte Carlo methods

8 High-dimensional problems

8.1 parametric empirical Bayes
8.2 linear models for high-dimensiona1 parameters
8.3 high-dimensiona1 multiple testing
8.4 high-dimensiona1 estimation and prediction

数据分析

一 基本信息

开课学院（系）和学科：理学院 数学系

课程代码：

课程名称：数据分析

学时/学分：48 学时/3 学分

预修课程：《高等代数》、《概率论与数理统计》

课程主要内容：线性回归模型，一般方差分量模型、广义线性模型、面板数据模型

适应专业学科： 数学系硕士研究生，非数学类专业博士生

教材/教学参考书：

【1】王松桂，史建红等《线性模型引论》，科学出版社，2004

【2】王松桂，陈敏等，《线性统计模型》 高等教育出版社，1999

【3】D.C.M.，Montgomery, E.A. Peck, G.G. Vining, Introduction to linear regression analysis (Third Edition), John Wiley & Sons, Inc. 2001

【4】茆诗松，王静龙，濮晓龙，《高度数理统计》，高等教育出版社和施普林格出版社，1998.

二 课程简介

自然科学的发展经历由定性研究到定量研究的过程。具备用统计方法对各种试验数据进行分析的能力，是现代自然科学、社会科学、经济与管理学科和工程技术人员必须具备的基本素养之一。本课程为训练这类能力打下一定的基础。

数据分析是关于各学科领域试验数据资料的收集、整理、分析和推断的统计学科分支，它是数学系硕士研究生基础课，也可供非数学类专业博士生选修。本课程通过讲解各种回归模型、各种方差分量模型的统计基础理论及几种统计软件的应用方法，使得学生对分析实验数据的统计分析思想有深刻的理解，能熟练掌握各类试验数据统计建模的基本原理和方法，并能借助相应的统计软件分析和解决实际问题。

三 教学大纲

1 随机向量

1.1 均值向量与协方差

1.2 随机向量的二次型

1.3 正态随机向量

1.4 卡方分布

要求：掌握基本的数学推导技巧。

2 回归参数的估计

2.1 最小二乘估计

2.2 最小二乘估计的性质

2.3 约束最小二乘估计

2.4 回归诊断

2.5 Box-Cox 变换

2.6 广义最小二乘估计

2.7 复共线性

2.8 岭估计

2.9 主成分估计

要求：掌握基本概念和原理，数学推导技巧，能用统计软件分析解决实际问题。

3 假设检验与预测

3.1. 一般线性假设

3.2. 回归方程的显著性检验

3.3. 回归系数的显著性检验

3.4 异常点检验

3.5 因变量的预测

要求：掌握基本概念和原理，数学推导技巧，能用统计软件分析解决实际问题。

4 回归方程的选择

4.1 评价回归方程的标准

4.2 计算所有可能的回归

4.3 计算最优子集回归

4.4 逐步回归

掌握基本概念和原理，能用统计软件对实验数据进行统计建模。

5 方差分析模型

5.1 单因素方差分析

5.2 双因素方差分析

5.3 正交试验设计与方差分析

要求：掌握基本概念和原理，数学推导技巧，能用统计软件分析解决实际问题。

6 广义线性模型

6.1 Logistic 回归模型

6.2. Poisson 回归

6.3. 广义线性模型

要求：掌握模型的适应范围，能用统计软件分析解决实际问题。

7 协方差分析模型

7.1 一般分块线性模型

7.2 参数估计

7.3 假设检验

7.4 计算方法

要求：掌握模型的适用范围，理解分析方法的基本思想，能用统计软件分析解决实际问题。

8 混合效应模型

8.1 固定效应的估计

8.2 随机效应的预测

8.3 混合模型方程

8.4 方差分析估计

8.5 极大似然估计

要求：掌握模型的适用范围，理解分析方法的基本思想，能用统计软件分析解决实际问题。

9 面板数据模型

9.1 面板数据模型概述

9.2 模型形式设定检验

9.3 变截距模型

9.4 变系数模型

Data Analysis

I Course Description

Data Analysis is a subject branch of statistics. It studies the approaches how to collect、arrange、analyze and make inference for the datum obtained from various trials, This course is an elementary mathematical course, which is intended for graduate students who major in mathematics as postgraduates. This course focuses on: (1) several regression models and their fundamental statistical theory, (2) several variance component models and their fundamental statistical theory. The use of related statistical packages will be demonstrated. The object of this course enables the students to grasp the basic concepts、mathematical principle and modeling methods of data analysis and to apply these techniques to analyze and solve relative practical problems.

II Contents

1 Random Vector

Mean vector and Covariance Matrix
Quadratic form of random vector
Normal random vector
χ^2 distribution

Basic requirements: Grasp the basic mathematical techniques for obtaining the main results.

2 Parameter Estimation for Regression Model

Least square estimation
Properties on Least square estimators
Constrained least square estimation
Regression Diagnostics
Box-Cox transformation
General least square estimation
Multicollinearity

Ridge estimator

Principal component estimator

Basic requirements: Grasp the basic concepts, principles and the basic mathematical techniques for obtaining the main results. Possess a capability to apply the regression approaches and statistical software to analyze and solve practical problems.

3 Hypothesis Testing and Prediction

Testing general linear hypothesis

Testing significance of regression model

Testing significance of coefficients of regression model

Testing outliers

Prediction of the dependent variable

Basic requirements: Grasp the basic concepts, principles and the basic mathematical techniques for obtaining the main results. Possess a capability to apply the test approaches and statistical software to analyze and solve practical problems.

4 Variable Selection and Model Building

Criteria for selecting regression models

All possible regression models

Evaluating best subset regression models

Stepwise regression methods

Basic requirements: Grasp the basic idea and principle, and possess a capability to apply the regression techniques to modeling data .

5 Variance Analysis Model

One-factor analysis of variance

Two-factor analysis of variance

Experimental design and its analysis of vriance

Basic requirements: Grasp the basic concepts, principles and the basic mathematical techniques for obtaining the main results. Possess a capability to apply the test approaches and statistical software to analyze and solve practical problems.

6 Generalized Linear Model

Logistic regression model

Poisson regression

The generalized linear model

Basic requirements: Understand the adaptive scope of these models, possess a capability to apply these techniques and statistical software to analyze and solve practical problems.

7 Covariance Analysis Model

General partition linear model

Parameter estimation

Tests of hypothesis

Computation methods

Basic requirements: Understand the adaptive scope of these models and analysis principle, possess a capability to apply these techniques and statistical software to analyze and solve practical problems.

8 Mixed Model

Estimating the fixed effects

Predicting the random effects

Mixed model equation

Variance analysis estimator

Maximum likelihood estimator

Basic requirement: Understand the adaptive scope of these models and analysis principle, possess a capability to apply these techniques and statistical software to analyze and solve practical problems.

9 Panel Data Models

Introduction

Testing model specification

Variable intercept model

Variable coefficient model

Basic requirements: Understand the basic concepts and principle, and can be able to sampling with the help of statistical software.

测度与概率论

一 基本信息

开课学院（系）和学科： 理学院数学系 数学

课程代码：X071505

课程名称： 《测度与概率论》

学时/学分：54 /3

开课时间：第二学期

预修课程： 概率论，实变函数

教材和主要参考书：

【1】Robert, B. A. and Catherine, A. D., PROBABILITY & MEASURE THEORY. (Second Edition) Academic Press, San Diego. 2000.

【2】严加安， 测度与积分， 高等教育出版社， 1998

【3】严士健、 刘秀芳， 测度与概率. 北京师范大学出版社, 1994

二 课程简介

本课程是随机数学的基础理论课，内容分为两大部分。第一部分是测论。内容包括：集类、概率测度及积分。第二部分是概率论，内容包括：分布函数、随机变量、期望、独立性、各种收敛概念、大数定律和随机级数、特征函数、中心极限定理、随机徘徊和条件期望、马尔科夫性、鞅论初步。

三 教学大纲

1 集合与测度

集合论初步，距离空间，集类及基本方法，测度空间与概率空间，可测函数，随机变量与 L 系方法。

2 可测函数与积分

积分与数学期望，Lebesgue 分解定理，Randon-Nikodym 定理， L^p 空间，可测函数序列的收敛性.

3 乘积空间

乘积空间， 乘积测度与 Fubini 定理， 无穷维乘积空间， Kolmogorov 扩张定理， 测度的弱收敛， Polish 空间.

4 条件期望与鞅

条件期望与 Hilbert 空间， 鞅， 鞅收敛定理， 一致可积与鞅。 鞅的应用。

5 大数定律与中心极限定理

大数定律和随机级数， 特征函数与中心极限定理， 无穷可分分布与稳定分布， 大偏差与收敛速度。

Measure and Probability Theory

I Course Description

This subject assumes to be a basic theory course of random theory. It is an introductory course emphasizing measure theory and probability theory. It covers two topics. The first topic which called measure theory includes category of sets, probability measure, and integral. The second topic is probability theory. It includes probability distributions, stochastic variables, expected values, independent, all different type concepts of convergence, the central limit theorem and random series, characteristic function, random walk principles and conditional probability, Markov chains, and theory of martingales.

II Contents

1 Set and Measure

1.1 Elementary of set theory
1.2 Distance space
1.3 Set class and basic methods
1.4 Measure space and probability space
1.5 Measurable function
1.6 Random variable and L-system method

2 Measurable Functions and Integration

2.1 Integration and Expectation
2.2 Lebesgue decomposition theorem
2.3 Randon-Nikodym theorem
2.4 L^p spaces
2.5 Convergence of sequences of measurable functions

3 Product Space

3.1 Product space
3.2 Product measure and Fubini theory

3.3 Infinite product space

3.4 Kolmogorov Theorem of extension of measures

3.5 Weak convergence of measures

3.6 Polish space

4 Conditional Expectation and Martingale

4.1 Conditional expectation and Hilbert spaces

4.2 Martingales

4.3 Martingale convergence theorem

4.4 Uniform integrability and martingale theory

4.5 Applications of martingale theory

5 The Laws of Large Numbers and The Central Limit Theorem

5.1 The laws of large numbers and random series

5.2 Characteristic function and the central limit theorem

5.3 Infinitely divisible distributions and stable distributions

5.4 Large derivations and convergence speed

多元统计分析

一 基本信息

开课学院（系）和学科： 理学院数学系 数学
课程代码：
课程名称：《多元统计分析》（Multivariate Statistical analysis）
学时/学分：54/3
开课时间：第一学期
预修课程：概率论、实变函数、数理统计
教材和主要参考书：

【1】 Anderson, T.W., An Introduction to Multivariate Statistical Analysis. Wiley Interscience, 2003

【2】Johnson,R.A. and Wichern, D.W. (2007).实用多元统计分析. 清华大学出版社.

二 课程简介

本课程是统计学科的基础课程， 内容包括：1.多元正态分布;2.值向量的统计推断,包括 Hotelling T 统计量,似然比检验等;3.均值量的比较,包括两个均值向量的比较,多个均值向量的比较(MANOVA),协方差矩阵相等性的检验等;4.多元线性回归模型,包括最小二乘估回归模型的推断,模型检验,有时间相关误差的多重回归模型等;5.主分分析,协方差矩阵结构的推断;6.两个总体的分类,Bayesrule;Fisher 判别准则等。

三 教学大纲

1 多元正态分布

1.1 多元正态密度函数
1.2 极大似然估计
1.3 样本均值和样本方差的分布
1.4 样本均值和样本方差的大样本性质

2 均值向量的统计推断

2.1 检验均值向量与某一给定向量的相等性,
2.2Hotelling T 统计量
2.3 似然比检验统计量
2.4 置信域
2.5 总体均值向量的大样本推断

3 均值向量的比较

3.1 两总体均值向量的比较
3.2 多个多元总体均值向量的比较
3.3 协方差矩阵相等性的检验

4 多元线性回归模型

4.1 最小二乘估计,
4.2 回归模型的推断
4.3 模型检验
4.4 线性回归的概念
4.5 有时间相关误差的多重回归模型

5 主成分分析与协方差结构的推断

5.1 总体主成分
5.2 综合主成分的样本变差
5.3 检验特殊结构的协方差矩阵

6 判别与分类

6.1 两个总体的分类,
6.2 两个多元正态总体的分类,
6.3 多个总体的分类

Multivariate Statistical analysis

Ⅰ.Course Description

Multivariate statistical analysis is a fundamental course in modern statistics.Its content includes:1.multivariate normal distribution;2.statistical inference on mean vector, including Hotelling's T square statistics,likelihood ratio test;3.comparison between mean vectors,including the comparison between two mean vectors , MANOVA, test on the equality of covariance matrices;4.multivariate linear regression model,the least squares estimation,inferences about the regression model, model checking,multiple regression models with time dependent error;5.principal components and inference for structured covariance matrices;6. discriminantion and classification.

Ⅱ.Contents

1 The multivariate normal distribution

1.1The multivariate normal density and its properties

1.2Sampling from a multivariate normal distribution and maximum likelihood estimation

1.3Samping distribution of sample means and covariance matrix

1.4Large sample behavior of sample means and covariance matrix

2 Inferences about a mean vector

2.1The plausibility of a given vector for a normal population mean

2.2Hotelling's T and likelihood ratio tests

2.3Confidence regions and simultaneous comparisons of component means

2.4Large sample inference about a population mean vector

3 Comparisons of several multivariate means

3.1Comparing mean vectors from two populations

3.2Comparing several multivariate population means

3.3Testing for equality of covariance matrices

4 Multivariate linear regression models

4.1Least Squares estimation

4.2Inferences about the regression model

4.3Inferences from the estimated regression function

4.4Model checking

4.5Multivariate multiple regression

4.6Multiple regression models with time dependent errors

5 Principal components

5.1Population principal components

5.2Summarizing sample variation by principal components

5.3Testing special structured covariance matrices

6 Discriminantion and Classification

6.1Separation and classification for two populations

6.2Classification with two multivariate normal populations

6.3Fisher’s linear discriminant analysis

非参数统计

一 基本信息

开课学院（系）和学科：理学院 数学系

课程代码：

课程名称：非参数统计

学时/学分：48 学时/3 学分

开课学期：春季

预修课程：概率论与数理统计

适应专业学科：数学系统计学研究生，应用统计专业硕士学位研究生

教材/教学参考书：

【1】王星，非参数统计，清华大学出版社和 Springer，2009。

【2】孙山泽，非参数统计讲义，北京大学出版社，2000。

【3】吴喜之，非参数统计，中国统计出版社，1999。

【4】Larry Wasserman，All of Nonparametric Statistics，Springer-Verlag，2005.(有中译本，吴喜之：现代非参数统计，科学出版社，2008。）

【5】陈希孺，非参数统计，中国科学技术大学出版社，2012.

【6】吴喜之、王兆军，非参数统计方法，高等教育出版社，1996

【7】J.S.Simonoff,Smoothing Methods in Statistics,Springer Press,1996.

二 课程简介

非参数统计是研究当总体分布未知时如何分析总体特征的一门统计学分支学科，它在经济、金融、生命科学和社会学领域获得了广泛的应用。《非参数统计》课程将比较系统地介绍传统非参数统计理论并简要介绍现代非参数统计理论方法。本课程的任务是使研究生比较系统地掌握非参数统计的基本概念、分析问题的基本思想和常用方法，并能利用 R 统计软件分析解决实际数据问题。

三 教学大纲

1 基本概念

1.1 经验分布和分布探索

1.2 检验的相对效率

1.3 分位数和非参数估计

1.4 秩检验统计量

2 单一样本的统计推断

2.1 符号检验和分位数推断

2.2 Cox-Staut 趋势存在性检验

2.3 随机游程检验

2.4 Wilcoxon 符号秩检验

2.5 单组数据的位置参数置信区间估计

2.6 正态记分检验

2.7 分布的一致性检验

2.8 单一总体渐近相对效率比较

3 两独立样本数据的位置和尺度推断

3.1. Brown-Mood 中位数检验

3.2. Wilcoxon-Mann-Whitney 秩和检验

3.3. Mood 方差检验

3.4. Moses 方差检验

4 多组数据位置推断

4.1 Kruskal-Wallis 单因素方差分析

4.2 Jonckheere-Terpstra 检验

4.3 Friedman 秩方差分析法

4.4 随机区组数据的调整秩和检验

4.5 Cochran 检验

4.7 Durbin 不完全区组分析法

5 分类数据的关联分析

5.1 $r \times s$ 列联表和 χ^2 独立性检验；

5.2 χ^2 齐性检验

5.3 Fisher 精确性检验

5.4 Mantel-Haenszel 检验

5.5 关联规则

5.6 Ridit 检验

5.7 对数线性模型

6 秩相关和分位数回归

6.1 Spearman 秩相关检验

6.2. Kendall τ 相关检验

6.3. 多变量 Kendall 协和系数检验

6.4 Kappa 一致性检验

6.5 中位数回归系数法

6.6 线性分位数回归模型

7 非参数密度估计

7.1 直方图密度估计

7.2 核密度估计

7.3 k 近邻估计

8 一元非参数回归

8.1 核回归光滑模型

8.2 局部多项式回归

8.3 LOWESS 稳健回归

8.4 k 近邻回归

8.5 正交序列回归

8.6 罚最小二乘法

Nonparametric Statistics

I Course Description

Nonparametric Statistics studies mainly the statistical characters of population where the type of the population distribution is unknown, and the results of this subject have been wildly used in Economics, Finance, Medicine Science，Biology and Social Sciences. <<Nonparametric Statistics>> is an elective course for the graduate students who major in Statistics and applied statistics. This course focuses on: (1) Statistical inference for single sample, (2) Location Inference for a Few Groups of Data, (3) Association Study for Categorical Data, (4) Quantile Regression for Rank correlation Sum, (5) Nonparametric Density Estimation, (6) Univariate nonparametric Regression. The use of R statistical packages will be demonstrated. The object of this course enables the students to grasp the basic concepts、statistical principle and modeling methods of data analysis and to apply these techniques and the R statistical software to analyze and solve relative practical problems.

II Contents

1 Preliminary

1.1Empirical distributions and distribution exploring
1.2Relative efficiency of test
1.3Quantile and nonparametric estimation
1.4Rank testing statistics

2Statistical inference for single sample

2.1Sign test and quantile inference
2.2Testing for existence of Cox-Staut trend
2.3Random Runs test
2.4Wilcoxon sign rank test
2.5Confidence interval estimation of location parameter of single group data
2.6Normal scores test
2.7Consistency test of distributions
2.8Comparison for asymptotic relative efficiency

3Location and Scale Inference for Independent Two-Samples

3.1Brown-Mood median test

3.2Wilcoxon-Mann-Whitney rank sum test

3.3Friedman methods of variance analysis

4 Location Inference for a Few Groups of Data

4.1Kruskal-Wallis one-way ANOVA

4.2Jonckheere-Terpstra test

4.3Friedman methods of rank ANOVA

4.4Adjusted rank sum test for randomized block data

4.5Cochran test

4.6Durbin incomplete block analysis methods

5 Association Study for Categorical Data

5.1 r $\times$ s contingence table and χ^2 independence test

5.2 χ^2 test of homogeneity

5.3Fisher exact test

5.4Mantel-Haenszel test

5.5Association rules

5.6Ridit test

5.7Logarithm linear model

6 Quantile Regression for Rank correlation Sum

6.1Spearman rank correlation test

6.2 Kendall τ correlation test

6.3Multivariate Kendal concord coefficient test

6.4Kappa consistency test

6.5Method of median regression coefficient

6.6Linear quantile regression model

7 Nonparametric Density Estimation

7.1Histogram density estimation

7.2Kernel density estimation

7.3K- nearest neighbor estimation

8Univariate nonparametric Regression

8.1Kernel regression smoothing model

8.2Local polynomial regression

8.3LOWESS robust regression

8.4K-nearest neighbor regression

8.5Orthogonal sequences regression

8.6Penalizing least square method

随机过程

一 基本信息

课程代码：X071518
课程名称（中文）：随机过程
课程名称（英文）：Stochastic Process
学分/学时：68/4
课程实验数(小时)：0
开课时间：秋
课程类别：硕士生学位课
开课院系：理学院数学系　数学
任课教师（姓名/工号）：韩东/07842
预修课程：概率论
面向专业：理学院数学系研究生
参考教材：

【1】钱敏平, 龚光鲁,《随机过程论》, 北京大学出版社,1992.
【2】王梓坤,《随机过程论》,科学出版社, 1965.
【3】Ross, S. M., Stochastic Processes, John Wiley & Sons, 1997
【4】Karatzas, I., Shreve,S.E., Brownian Motion and Stochastic Calculus, Springer- Verlag, 1988.
【5】 Oksendal, B., Stochastic Differential Equations, Springer- Verlag, 1995.

二 课程简介

随机过程的一般理论 (存在定理), Poisson 过程与更新定理; 鞅 (上下鞅, 分解定理, 停时, 基本不等式, 收敛定理, 停时定理); 离散时间马氏链 (弱遍历定理, 不变测度, 平均回访时间, 转移概率的极限); 连续时间马氏链 (向前向后方程, 速率矩阵); 布朗运动 (样本轨道, 强马氏性与反射原理, 首达时的计算, 停时); 马氏过程 (半群与鞅问题, 强马氏性, Feynman-Kac 公式); 随机分析(随机积分, Ito 公式, Girsanov 定理, 随机微分方程, 扩散过程)；平稳过程与 ARMA 模型。

三 教学大纲

深刻理解 Kolmogorov 存在性定理, 掌握鞅, 马氏过程, 布朗运动, 扩散过程与随机分析的基本理论.

1 引论.

内容: 随机过程的概念与例子, Kolmogorov 存在性定理.

要求: 深刻理解 Kolmogorov 存在性的要义.

2 Poisson 过程与更新过程

内容: Poisson 过程的背景定义，到达时间与时间间隔的分布，Poisson 几种推广，更新过程及其极限定理。

要求：理解指数分布与 Poisson 过程的关系以及更新定理的含义。

3 可数状态的马氏过程

内容：状态空间的分解，弱遍历定理与强遍历定理，不变测度，转移速率与向前向后方程，强马氏性，转移概率的极限。

要求：会将状态空间进行分解，判断是否常返，零常返，正常返，会求周期及平均回访时间，会判断不变概率测度是否存在。会求转移概率的极限。

4 鞅过程.

内容: 上鞅,下鞅及分解定理, 极大极小不等式, 上穿不等式, Doob 不等式，收敛定理， 停时定理。

要求：掌握停时定理与收敛定理，理解修正定理的意义。

5 布朗运动

内容：布朗分布，鞅性，轨道性质，强马氏性，强再生性，转移半群，反射原理，最大值分布，常返性及某些击中分布。

要求：知道与布朗运动相联系的几个鞅，掌握它的轨道性质，强马氏性与强再生性，会求半群与无穷小生成元，会利用反射原理，了解常返性，会求几个常用的击中分布。

6 连续状态的马氏过程

内容：半群与无穷小生成元，Stroock—Varadhan 鞅问题，强马氏性，过程的截止，Feymann—Kac 公式，扩散过程。

要求：掌握半群与无穷小生成元及 Feymann—Kac 公式，了解 Stroock—Varadhan 鞅问题模型及具有强马氏性的条件。

7 随机分析

内容：Ito 微积分，Ito 公式，Brown 运动的鞅特征，Girsanov 定理，随机微分方程解的存在性唯一性，。

要求：深刻理解 Ito 微积分的定义与意义，会用 Ito 公式进行计算， 掌握 Levy 定理，Girsanov 定理。了解随机微分方程存在性与唯一性。

8 平稳过程与时间序列

内容：严平稳过程与宽平稳过程的定义及关系， 各态历经性，ARMA 模型。

要求：理解各态历经性质，掌握 ARMA 模型的应用。

Stochastic Process

I Course Description

The main content of this course includes: General theory of stochastic processes (Kolmogorov theorem), Poisson process and renewal theorems; Martingales (super-martingales and sub-martingales, Doob-Meyer decomposition, stopping times, fundamental inequalities, convergence theorems, optional sampling theorem); Discrete-time Markov Chains (weak ergodic theorems, invariant distributions, mean recurrence times, limits of transience probability); Continuous-time Markov Chains (Kolmogorov backward equation, Markov transition and rate kernels); Brownian motion (sample paths, strong Markov property and the reflection principle, computations based on passage times, stopping time); Markov processes (semigroup, the martingale problem, strong Markov property, Feynman-Kac formulas); Introduction to stochastic analysis (stochastic integration, Ito formula, the Girsanov theorem, stochastic differential equations, diffusion processes; Stationary processes and ARMA models.

II Contents

1 Introduction

the concept of stochastic process, examples
existence theorem of Kolmogorov.

2 Poisson process and renewal process.

the background of the Poisson process
the distribution of arrival time and time interval between two events,
inhomogeneous Poisson process and the compound Poisson process;
The general renewal process and its limit theorem.

3 Markov chain

3.1 discrete–time Markov chain
Transition matrix

Chapman–Kolmogorov equation
Recurrence and transience
Positive recurrence and null recurrence
Stationary distribution
3.2 Continuous-time Markov chain
Transition matrix
Infinitesimal generator
Kolmogorov's backward equation and forward equation
Stationary distribution
Birth-and-Death process

4 Martingale

Conditional expectation and filtration
Concepts of martingale, submartingale and supmartingale
Doob-Mayer's decomposition
Stopping times and Optional Sampling Theorem
Martingale Convergence Theorem

5 Brownian motion

Definition
The Markovian property of BM
The martingale property of BM
sampled quadratic variation
The reflected principle and the distribution of the maximum

7 Stochastic calculus

Mean-square convergence and mean-square calculus
Stochastic integral
Ito's formula
Girsanov's Theorem
Stochastic differential equation and solution
Black-Scholes Formula

8 Weakly Stationary Process

Weakly stationary process and auto-covariance function

Spectrum and the spectral density

spectral representation

Mean square ergodic theorem

ARMA

课程大纲

SYLLABUS

应用随机过程 2

Applied Stochastic Processes 4

贝叶斯统计 6

Bayesian Statistics 9

线性模型与回归分析 11

Linear Model and Regression Analysis 14

多元统计分析 17

Multivariate Statistical analysis 19

非参数统计 21

Nonparametric Statistics 24

统计计算 27

Statistical Computing 29

统计数据分析 30

Statistical Data Analysis 34

统计推断与决策 37

Statistical Inference and Decision 40

应用随机过程

一 基本信息

开课学院（系）和学科： 理学院数学系 数学
课程代码：X071545
课程名称： 《应用随机过程》
学时/学分： 72/4
开课时间：第一学期
预修课程：概率论
教材和主要参考书：
【1】《应用随机过程教程》龚光鲁、钱敏平 清华大学出版社 2004 年
【2】《应用随机过程》 钱敏平、龚光鲁 北京大学出版社 1998 年

二 课程简介

主要介绍随机过程的基本概念，离散状态空间的 Markov 过程，连续状态空间的 Markov 过程，鞅过程、$I\hat{t}0$积分及期权定价，平稳过程，时间序列分析.

三 教学大纲

1 概率统计要点回顾

内容：随机变量、条件概率及条件数学期望、独立性、大数定理、中心极限定理、样本估计、线性模型、随机样本与随机模拟（Monte Carlo 随机模拟）。

2 随机过程的基本概念

内容：随机过程的例子、定义、分类及性质

3 离散状态空间的 Markov 过程

内容：离散时间马儿可夫链、简单随机徘徊、应用举例（机器维修、市场占有率、股市价格模拟及分析）、连续时间马氏过程、Poisson 过程、Q 过程及无穷小生成元、排队论。

4 连续状态空间的 Markov 过程

内容：定义及性质、向后、向前过程、Brown 运动、无穷小生成元、Feller 过程、可逆 Markov 过程及平稳分布、扩散过程简介

5 鞅过程、$\hat{It0}$积分及期权定价

内容：鞅的定义、例子及性质、$\hat{It0}$积分的背景、定义以及它与 Markov 过程和鞅的关系、$\hat{It0}$随机微分方程和等价鞅测度在期权定价中的应用

6 平稳过程

内容：严平稳过程、宽平稳过程及其性质、例子、频谱分析方法、遍历性（时间平均等于空间平均）

7 时间序列分析

内容：ARMA 模型定义、性质及例子、ARMA 模型的平稳性及可逆性、ARMA 模型的定价与参数估计。ARCH 模型极其推广以及在金融证券中的应用。

Applied Stochastic Processes

I Course Description

The main contents include the basic concepts of stochastic processes, Markov processes with discrete and continuous state space, martingle processes, Ito integral and option price, stationary processes and time series analysis.

II Contents

1Reviews for Probability and Statistics

Random variable, conditional probability and conditional expectation, independence

The laws of large numbers and the central limit theorem

Linear model and estimation

Random sample and random simulation

2The Basic Concepts of Stochastic Processes

Examples and definitions of stochastic processes

classification and properties of stochastic processes

3 Markov Processes with the Space of Discrete States

Discrete time Markov Chains

Simple random walks

Examples with applications

Continuous time Markov processes

Poisson processes

Polish space

Q-processes and infinitesimal generator

Queue theory

4Markov Processes with the Space of Continuous States

Definitions and properties

Forward and backward processes

Brownian motions

Infinitesimal generator

Feller processes

Reversible Markov processes and stable distributions

Brief introduction to diffusion processes

5 Itô Integral and Option Pricing

Martingales

Itô Integral

Itô stochastic differential equations

Equivalent martingale measure and its applications to option pricing

6Stationary processes

Strictly stationary processes

Wide-sense stationary processes

Spectral Analysis

Ergodic

7Time Series Analysis

ARMA models

Stationary and reversibility of ARMA models

Parameter estimation for ARMA models

ARCH models and applications to finance

贝叶斯统计

一 基本信息

开课学院（系）和学科：理学院 数学系

课程代码：F071604

课程名称：贝叶斯统计

学时/学分：48 学时/3 学分

开课学期：春季

预修课程：概率论与数理统计

课程主要内容：线性回归模型，一般方差分量模型、广义线性模型、面板数据模型

适应专业学科： 数学系统计学、应用统计专业硕士学位研究生选修课

教材/教学参考书：

【1】Ghosh, J. K., Delampady, M., & Samanta, T. (Eds.). An introduction to Bayesian analysis: theory and methods. Springer, 2006.

【2】茆诗松 汤银才 贝叶斯统计 中国统计出版社, 2012.

【3】Berger, James O. Statistical decision theory and Bayesian analysis. Springer, 1985.

【4】Lee, Peter M. Bayesian statistics: an introduction. John Wiley & Sons, 2012.

二 课程简介

本课程是数学系统计学科硕士、博士研究生和应用统计专业硕士学位研究生的选修课。

本课程主要讲解贝叶斯推断与决策理论，贝叶斯先验选择和稳定性，贝叶斯思想在假设检验和模型选择中的体现以及贝叶斯方法在高维问题中的应用，贝叶斯计算等。课程的学习

使得学生对贝叶斯统计分析的基本思想和理论，基本方法、计算以及其应用有比较全面的了解，并能运用贝叶斯统计分析思想和方法分析各种实际数据，并能借助相应的统计软件分析和解决实际问题。

三 教学大纲

1 基本知识

1.l 常见参数模型
1.2 似然函数
1.3 充分统计量和辅助统计量
1.4 经典统计推断中的三个基本问题

2 贝叶斯推断与决策理论

2.l 贝叶斯推断
2.2 贝叶斯决策理论
2.3 贝叶斯推断中的常见问题

3 效用、先验和贝叶斯稳定性

3.l 效用、先验和理性推断
3.2 贝叶斯方法的核心元素
3.3 利用主观先验的贝叶斯分析
3.4 稳定性和敏感性
3.5 先验的种类
3.6 后验分布的稳定性分析

4 大样本方法

4.l 后验分布的极限
4.2 后验分布的渐进展开
4.3 拉普拉斯逼近

5 对低维参数的先验的选择

5.l 构造客观先验分布的方法
5.2 可交换性
5.3 先验分布中的超参数

6 假设检验和模型选择

6.l 贝叶斯因子和后验概率的界
6.2 贝叶斯 p 值
6.3 稳定的贝叶斯异常值检测方法
6.4 客观的贝叶斯因子

7 贝叶斯计算

7.l 逼近
7.2e-m 算法
7.3 蒙特卡洛抽样
7.4 马氏链蒙特卡洛方法

8 高维问题

8.l 参数型的经验贝叶斯
8.2 针对高维参数的线型模型
8.3 高维中的多重假设检验
8.4 高维中的估计和预测

Bayesian Statistics

I Course Description

<< Bayesian Statistics >> is an elective statistical course, which is intended for postgraduate students who major in statistics and applied statistics. This course introduces the fundamental theories of Bayesian statistical analysis and its applications. It mainly covers Bayesian inference and decision theory，the choice of Bayesian prior and Bayesian robustness，Bayesian statistics in hypothesis testing and model selection，the application of Bayesian analysis in high-dimensional problems，Bayesian computation，etc. The object of this course enables the students to grasp the fundamental ideas, theories and methods of Bayesian Statistics and to apply these approaches the statistical software to analyze and solve relative practical problems.

II Contents

1 Preliminaries

1.1 common parametric models
1.2 Likelihood function
1.3 sufficient statistics and ancillary statistics
1.4 three basic problems of inference in classical statistics

2 Bayesian inference and decision theory

2.1 Bayesian inference
2.2 Bayesian decision theory
2.3 Common problems of Bayesian inference

3 Utility，prior，and Bayesian robustness

3.1 utility，prior，and rationa1 preference
3.2 rationality axioms leading to the Bayesian approach
3.3 Bayesian analysis with subjective prior
3.4 robustness and sensitivity
3.5 classes of priors

3.6 posterior robustness

4 Large sample methods

4.1 limit of posterior distribution
4.2 asymptotic expansion of posterior distribution
4.3 Laplace approximation

5 Choice of priors for low-dimensiona1.parameters

5.1 different methods of construction of objective priors
5.2 exchangeability
5.3 hyperparameters for prior

6 Hypothesis testing and mode1.selection

6.1 bounds on Bayes factors and posterior probabilities
6.2 Bayesian p-value
6.3 robust Bayesian outlier detection
6.4 nonsubjective Bayes factors

7 Bayesian computations

7.1 analytic approximation
7.2 the e-m algorithm
7.3 Monte Carlo sampling
7.4 Markov chain Monte Carlo methods

8 High-dimensional problems

8.1 parametric empirical Bayes
8.2 linear models for high-dimensiona1 parameters
8.3 high-dimensiona1 multiple testing
8.4 high-dimensiona1 estimation and prediction

线性模型与回归分析

一 基本信息

开课学院（系）和学科：理学院 数学系

课程代码：P071001

课程名称：线性模型与回归分析

学时/学分：48 学时/3 学分

开课学期：秋季

预修课程：《高等代数》、《概率论与数理统计》

课程主要内容：线性回归模型，一般方差分量模型、广义线性模型、面板数据模型

适应专业学科： 数学系应用统计专业硕士学位研究生

教材/教学参考书：

【1】王松桂，史建红等《线性模型引论》，科学出版社，2004

【2】王松桂，陈敏等，《线性统计模型》 高等教育出版社，1999

【3】D.C.M.，Montgomery, E.A. Peck, G.G. Vining, Introduction to linear regression analysis (Third Edition), John Wiley & Sons, Inc. 2001

【4】茆诗松，王静龙，濮晓龙，《高度数理统计》，高等教育出版社和施普林格出版社，1998.

二 课程简介

本课程是面向数学系各专业硕士研究生开设的。

自然科学的发展经历由定性研究到定量研究的过程。具备用统计方法对各种试验数据进行分析的能力，是现代自然科学、社会科学、经济与管理学科和工程技术人员必须具备的基本素养之一。本课程为训练这类能力打下一定的基础。

数据分析是关于各学科领域试验数据资料的收集、整理、分析和推断的统计学科分支，它是数学系硕士研究生基础课，也可供非数学类专业博士生选修。本课程通过讲解各种回归模型、各种方差分量模型的统计基础理论及几种统计软件的应用方法，使得学生对分析实验数据的统计分析思想有深刻的理解，能熟练掌握各类试验数据统计建模的基本原理和方法，并能借助相应的统计软件分析和解决实际问题。

三 教学大纲

1 随机向量

1.1 均值向量与协方差
1.2 随机向量的二次型
1.3 正态随机向量
1.4 卡方分布

2 回归参数的估计

2.1 最小二乘估计
2.2 最小二乘估计的性质
2.3 约束最小二乘估计
2.4 回归诊断
2.5 Box-Cox 变换
2.6 广义最小二乘估计
2.7 复共线性
2.8 岭估计
2.9 主成分估计

3 假设检验与预测

3.1. 一般线性假设
3.2. 回归方程的显著性检验
3.3. 回归系数的显著性检验
3.4 异常点检验
3.5 因变量的预测

4 回归方程的选择

4.1 评价回归方程的标准
4.2 计算所有可能的回归
4.3 计算最优子集回归
4.4 逐步回归

5 方差分析模型

4.1 单因素方差分析
4.2 双因素方差分析

4.3 正交试验设计与方差分析

6 广义线性模型

6.1 Logistic 回归模型
6.2. Poisson 回归
6.3. 广义线性模型

7 协方差分析模型

7.1 一般分块线性模型
7.2 参数估计
7.3 假设检验
7.4 计算方法

8 混合效应模型

8.1 固定效应的估计
8.2 随机效应的预测
8.3 混合模型方程
8.4 方差分析估计
8.5 极大似然估计

9 面板数据模型

9.1 面板数据模型概述
9.2 模型形式设定检验
9.3 变截距模型
9.4 变系数模型

Linear Model and Regression Analysis

I Course Description

<< Linear Model and Regression Analysis >> is a subject branch of statistics. It studies the approaches how to collect、arrange、analyze and make inference for the data obtained from various trials, This course is an elementary statistical course, which is intended for graduate students who major in applied statistics. This course focuses on: (1) several regression models and their fundamental statistical theory, (2) several variance component models and their fundamental statistical theory. The use of related statistical packages will be demonstrated. The object of this course enables the students to grasp the basic concepts、mathematical principle and modeling methods of data analysis and to apply these techniques the statistical software to analyze and solve relative practical problems.

II Contents

1 Random Vector

Mean vector and Covariance Matrix
Quadratic form of random vector
Normal random vector
χ^2 distribution

2 Parameter Estimation for Regression Model

Least square estimation
Properties on Least square estimators
Constrained least square estimation
Regression Diagnostics
Box-Cox transformation
General least square estimation
Multicollinearity
Ridge estimator
Principal component estimator

3 Hypothesis Testing and Prediction

Testing general linear hypothesis
Testing significance of regression model
Testing significance of coefficients of regression model
Testing outliers
Prediction of the dependent variable

4Variable Selection and Model Building

Criteria for selecting regression models
All possible regression models
Evaluating best subset regression models
Stepwise regression methods

5Variance Analysis Model

One-factor analysis of variance
Two-factor analysis of variance
Experimental design and its analysis of variance

6Generalized Linear Model

Logistic regression model
Poisson regression
The generalized linear model

7Covariance Analysis Model

General partition linear model
Parameter estimation
Tests of hypothesis
Computation methods

8Mixed Model

Estimating the fixed effects
Predicting the random effects
Mixed model equation

Variance analysis estimator

Maximum likelihood estimator

9Panel Data Models

Introduction

Testing model specification

Variable intercept model

Variable coefficient model

多元统计分析

一 基本信息

开课学院（系）和学科： 理学院数学系 数学

课程代码：

课程名称：《多元统计分析》（Multivariate Statistical analysis）

学时/学分：54/3

开课时间：第一学期

预修课程：概率论、实变函数、数理统计

教材和主要参考书：

【1】Anderson, T.W., An Introduction to Multivariate Statistical Analysis. Wiley Interscience, 2003

【2】Johnson,R.A. and Wichern, D.W. (2007).实用多元统计分析.清华大学出版社.

二 课程简介

本课程是统计学科的基础课程， 内容包括：1.多元正态分布;2.值向量的统计推断,包括 Hotelling T 统计量,似然比检验等;3.均值量的比较,包括两个均值向量的比较,多个均值向量的比较(MANOVA),协方差矩阵相等性的检验等;4.多元线性回归模型,包括最小二乘估回归模型的推断,模型检验,有时间相关误差的多重回归模型等;5.主分分析,协方差矩阵结构的推断;6.两个总体的分类,Bayesrule;Fisher 判别准则等。

三 教学大纲

1 多元正态分布

1.1 多元正态密度函数

1.2 极大似然估计

1.3 样本均值和样本方差的分布

1.4 样本均值和样本方差的大样本性质

2 均值向量的统计推断

2.1 检验均值向量与某一给定向量的相等性,
2.2Hotelling T 统计量
2.3 似然比检验统计量
2.4 置信域
2.5 总体均值向量的大样本推断

3 均值向量的比较

3.1 两总体均值向量的比较
3.2 多个多元总体均值向量的比较
3.3 协方差矩阵相等性的检验

4 多元线性回归模型

4.1 最小二乘估计,
4.2 回归模型的推断
4.3 模型检验
4.4 线性回归的概念
4.5 有时间相关误差的多重回归模型

5 主成分分析与协方差结构的推断

5.1 总体主成分
5.2 综合主成分的样本变差
5.3 检验特殊结构的协方差矩阵

6 判别与分类

6.1 两个总体的分类,
6.2 两个多元正态总体的分类,
6.3 多个总体的分类

Multivariate Statistical analysis

Ⅰ Course Description

Multivariate statistical analysis is a fundamental course in modern statistics.Its content includes:1.multivariate normal distribution;2.statistical inference on mean vector, including Hotelling's T square statistics,likelihood ratio test;3.comparison between mean vectors,including the comparison between two mean vectors , MANOVA, test on the equality of covariance matrices;4.multivariate linear regression model,the least squares estimation,inferences about the regression model, model checking,multiple regression models with time dependent error;5.principal components and inference for structured covariance matrices;6. discriminantion and classification.

Ⅱ Contents

1 The multivariate normal distribution

1.1The multivariate normal density and its properties

1.2Sampling from a multivariate normal distribution and maximum likelihood estimation

1.3Samping distribution of sample means and covariance matrix

1.4Large sample behavior of sample means and covariance matrix

2 Inferences about a mean vector

2.1The plausibility of a given vector for a normal population mean

2.2Hotelling's T and likelihood ratio tests

2.3Confidence regions and simultaneous comparisons of component means

2.4Large sample inference about a population mean vector

3 Comparisons of several multivariate means

3.1Comparing mean vectors from two populations

3.2Comparing several multivariate population means

3.3Testing for equality of covariance matrices

4 Multivariate linear regression models

4.1Least Squares estimation

4.2Inferences about the regression model

4.3Inferences from the estimated regression function

4.4Model checking

4.5Multivariate multiple regression

4.6Multiple regression models with time dependent errors

5 Principal components

5.1Population principal components

5.2Summarizing sample variation by principal components

5.3Testing special structured covariance matrices

6 Discriminantion and Classification

6.1Separation and classification for two populations

6.2Classification with two multivariate normal populations

6.3Fisher’s linear discriminant analysis

非参数统计

一 基本信息

开课学院（系）和学科：理学院 数学系

课程代码：

课程名称：非参数统计

学时/学分：48 学时/3 学分

开课学期：春季

预修课程：概率论与数理统计

适应专业学科：数学系统计学研究生，应用统计专业硕士学位研究生

教材/教学参考书：

【1】王星，非参数统计，清华大学出版社和 Springer，2009。

【2】孙山泽，非参数统计讲义，北京大学出版社，2000。

【3】吴喜之，非参数统计，中国统计出版社，1999。

【4】Larry Wasserman，All of Nonparametric Statistics，Springer-Verlag，2005.(有中译本，吴喜之：现代非参数统计，科学出版社，2008。）

【5】陈希孺，非参数统计，中国科学技术大学出版社，2012.

【6】吴喜之、王兆军，非参数统计方法，高等教育出版社，1996

【7】J.S.Simonoff,Smoothing Methods in Statistics,Springer Press,1996.

二 课程简介

非参数统计是研究当总体分布未知时如何分析总体特征的一门统计学分支学科，它在经济、金融、生命科学和社会学领域获得了广泛的应用。《非参数统计》课程将比较系统地介绍传统非参数统计理论并简要介绍现代非参数统计理论方法。本课程的任务是使研究生比较系统地掌握非参数统计的基本概念、分析问题的基本思想和常用方法，并能利用 R 统计软件分析解决实际数据问题。

三 教学大纲

1 基本概念

1.1 经验分布和分布探索

1.2 检验的相对效率

1.3 分位数和非参数估计

1.4 秩检验统计量

2 单一样本的统计推断

2.1 符号检验和分位数推断

2.2 Cox-Staut 趋势存在性检验

2.3 随机游程检验

2.4 Wilcoxon 符号秩检验

2.5 单组数据的位置参数置信区间估计

2.6 正态记分检验

2.7 分布的一致性检验

2.8 单一总体渐近相对效率比较

3 两独立样本数据的位置和尺度推断

3.1. Brown-Mood 中位数检验

3.2. Wilcoxon-Mann-Whitney 秩和检验

3.3. Mood 方差检验

3.4. Moses 方差检验

4 多组数据位置推断

4.1 Kruskal-Wallis 单因素方差分析

4.2 Jonckheere-Terpstra 检验

4.3 Friedman 秩方差分析法

4.4 随机区组数据的调整秩和检验

4.5 Cochran 检验

4.7 Durbin 不完全区组分析法

5 分类数据的关联分析

5.1 $r \times s$ 列联表和 χ^2 独立性检验；

5.2 χ^2 齐性检验

5.3 Fisher 精确性检验

5.4 Mantel-Haenszel 检验

5.5 关联规则

5.6 Ridit 检验
5.7 对数线性模型

6 秩相关和分位数回归

6.1 Spearman 秩相关检验
6.2. Kendall τ 相关检验
6.3. 多变量 Kendall 协和系数检验
6.4 Kappa 一致性检验
6.5 中位数回归系数法
6.6 线性分位数回归模型

7 非参数密度估计

7.1 直方图密度估计
7.2 核密度估计
7.3 k 近邻估计

8 一元非参数回归

8.1 核回归光滑模型
8.2 局部多项式回归
8.3 LOWESS 稳健回归
8.4 k 近邻回归
8.5 正交序列回归
8.6 罚最小二乘法

Nonparametric Statistics

I Course Description

Nonparametric Statistics studies mainly the statistical characters of population where the type of the population distribution is unknown, and the results of this subject have been wildly used in Economics, Finance, Medicine Science，Biology and Social Sciences. <<Nonparametric Statistics>> is an elective course for the graduate students who major in Statistics and applied statistics. This course focuses on: (1) Statistical inference for single sample, (2) Location Inference for a Few Groups of Data, (3) Association Study for Categorical Data, (4) Quantile Regression for Rank correlation Sum, (5) Nonparametric Density Estimation, (6) Univariate nonparametric Regression. The use of R statistical packages will be demonstrated. The object of this course enables the students to grasp the basic concepts、statistical principle and modeling methods of data analysis and to apply these techniques and the R statistical software to analyze and solve relative practical problems.

II Contents

1 Preliminary

1.1Empirical distributions and distribution exploring
1.2Relative efficiency of test
1.3Quantile and nonparametric estimation
1.4Rank testing statistics

2Statistical inference for single sample

2.1Sign test and quantile inference
2.2Testing for existence of Cox-Staut trend
2.3Random Runs test
2.4Wilcoxon sign rank test
2.5Confidence interval estimation of location parameter of single group data
2.6Normal scores test
2.7Consistency test of distributions
2.8Comparison for asymptotic relative efficiency

3Location and Scale Inference for Independent Two-Samples

3.1Brown-Mood median test

3.2Wilcoxon-Mann-Whitney rank sum test

3.3Friedman methods of variance analysis

4 Location Inference for a Few Groups of Data

4.1Kruskal-Wallis one-way ANOVA

4.2Jonckheere-Terpstra test

4.3Friedman methods of rank ANOVA

4.4Adjusted rank sum test for randomized block data

4.5Cochran test

4.6Durbin incomplete block analysis methods

5 Association Study for Categorical Data

5.1 r $\times$ *s* contingence table and χ^2 independence test

5.2 χ^2 test of homogeneity

5.3Fisher exact test

5.4Mantel-Haenszel test

5.5Association rules

5.6Ridit test

5.7Logarithm linear model

6 Quantile Regression for Rank correlation Sum

6.1Spearman rank correlation test

6.2 Kendall τ correlation test

6.3Multivariate Kendal concord coefficient test

6.4Kappa consistency test

6.5Method of median regression coefficient

6.6Linear quantile regression model

7 Nonparametric Density Estimation

7.1Histogram density estimation

7.2Kernel density estimation

7.3K- nearest neighbor estimation

8Univariate nonparametric Regression

8.1Kernel regression smoothing model

8.2Local polynomial regression

8.3LOWESS robust regression

8.4K-nearest neighbor regression

8.5Orthogonal sequences regression

8.6Penalizing least square method

统计计算

一 基本信息

开课学院（系）和学科：理学院 数学系

课程代码：P071577

课程名称：统计计算

学时/学分：48 学时/3 学分

开课学期：春季

预修课程：概率论与数理统计

课程主要内容： 计算数学基本方法，优化算法，随机模拟算法等

适应专业学科： 数学系应用统计专业硕士学位研究生

教材/教学参考书：

【1】高惠璇，统计计算，北京大学出版社，1995

【2】Geof H. Givens and Jennifer A. Hoeting, Computational Statistics, Wiley-Interscience，2005

【3】张平文，李铁军，数值分析，北京大学出版社，2007

【4】Christian P. Robert, Monte Carlo Statistical Methods，Springer-Verlag GmbH, 1999

二 课程简介

本课程是为数学系应用统计专业硕士学位研究生开设的专业基础课。课程主要讲授统计计算的一些常用算法。内容包括，方程求根，优化，数值线性代数，积分，随机模拟算法，抽样技术，和 Bootstrap 方法等。本课程的学习要求学生对各种统计模型分析中涉及到的计算方法思想有深刻的理解，并能借助相应的统计软件分析和解决实际问题。

三 教学大纲

1 引言和 Matlab 简介

2 方程求根，最大似然估计

3 随机数生成

4 插值和逼近

5 回归分析和正交多项式

6 积分数值解
7 蒙特卡洛积分
8 重要性抽样和数值实现
9 马尔科夫链蒙特卡洛
10 高级采样技巧
11 LU, Cholesky 和 QR 分解
12 线性代数迭代算法
13 优化和非线性方程组
14 EM 优化
15 Bootstrap 方法
16 Bootstrap 方法实现

Statistical Computing

I Course Description

<< Statistical Computing>> is an elective statistical course, which is intended for postgraduate students who major in applied statistics. This course introduces general computational methods in statistical applications. Topics include roots of equations, optimization, numerical linear algebra, integration, stochastic simulations, sampling techniques, and Bootstrap methods, etc. The object of this course enables the students to grasp the fundamental ideas, theories and methods of statistical computing and to apply these techniques the statistical software to analyze and solve relative practical problems.

II Contents

Lecture 1 Introduction and Matlab tutorial
Lecture 2 Roots of equations, maximum likelihood estimates
Lecture 3 Random number generation
Lecture 4 Interpolation, and approximation
Lecture 5 Regression analysis, and orthogonal polynomials、
Lecture 6 Integration numerical solution
Lecture 7 Monte Carlo as a numerical integration
Lecture 8 Importance sampling and implementation
Lecture 9 Markov Chain Monte Carlo
Lecture 10 Enhanced sampling techniques
Lecture 11 LU, Cholesky, and QR factorization
Lecture 12 Iteration algorithms for linear algebra
Lecture 13 Nonlinear systems and optimization
Lecture 14 EM optimization
Lecture 15 Bootstrap methods
Lecture 16 Implementation of Bootstrap

统计数据分析

一基本信息

开课学院（系）和学科：理学院 数学系

课程代码：P071003，MA332

课程名称：统计数据分析

学时/学分：48 学时/3 学分

开课学期：春季

预修课程：《线性代数》，《概率论与数理统计》，《最优化方法》

课程主要内容：生存分析，统计学习理论，金融时间序列分析

适应专业学科：数学系应用数学、概率统计专业本科生，应用统计专业硕士学位研究生

教材/教学参考书：

【1】彭非、王伟，生存分析，中国人民大学出版社，2004。

【2】J.F.Lawless 著,茆诗松、濮晓龙、刘忠 译，葛广平 校， 寿命数据中的统计模型与方法，中国统计出版社，1998。

【3】陈家鼎，生存分析与可靠性，北京大学出版社，2005。

【4】Ruey S. Tsay：Analysis of Financial Time Series，John Wiley & Sons, Inc.(王辉、潘家柱译：金融时间序列分析，人们邮电出版社，2009。）

【5】阎平凡、张长水，人工神经网络与模拟进化计算(第二版)，清华大学出版社，2005.

【6】T.Hastie、R.Tibshirani、J.Friedman 著，范明、柴玉梅等译，统计学习基础----数据挖掘、推理与预测，电子工业出版社，2004.

【7】林建忠，《金融信息分析》，上海交通大学出版社，2014 年 10 月将出版

二 课程简介

本课程是面向数学系应用数学、概率统计专业本科生，应用统计专业硕士研究生开设的一门统计类选修课程，也可作为生命科学、生物学、医学及金融类学生选修课程。

自然科学的发展经历由定性研究到定量研究的过程。具备用统计方法对生命科学、生物学和医学领域各种试验数据以及金融市场实际数据进行分析的能力，

是数学和统计学本科生和研究生必须具备的基本素养之一。本课程为训练这类能力打下一定的基础。

本课程主要讲解生存分析、统计学习理论和金融时间序列分析三个统计分支学科的数据分析、建模的基础理论及相应统计软件的应用方法，使得学生对分析实际数据的统计分析思想有深刻的理解，能熟练掌握各类试验数据统计建模的基本原理和方法，并能借助相应的统计软件分析和解决实际问题。

三 教学大纲

1 生存数据与变量类型

1.1 右删失
1.2 左删失和区间删失
1.3 截尾
1.4 分组数据

2 基本函数与参数模型

2.1 生存分析的基本函数
2.2 生存数据建模的参数模型
2.3 次序统计量的分布与极值分布
2.4 删失和截尾数据的似然函数

3 估计基本生存特征函数的非参数方法

3.1. 寿命表法
3.2. 右删失数据的生存函数和累积死亡力函数的估计
3.3. Turnbull 估计

4 比较生存函数的非参数方法

4.1 两个生存函数的比较
4.2 分层情形下的 Mantel-Haenszel 检验
4.3 M 个样本情形的比较

5 比率危险率模型

5.1 参数型比例危险率模型；
5.2 Cox 半参数比例危险率模型

6 神经网络

6.1 神经网络的基本特征和性质
6.2. MP 模型和 Hebb 学习规则
6.3. 线性阈值单元与感知器
6.4 多层前馈网络的映射作用
6.5 BP 网络及 BP 算法
6.6 径向基函数网络

7 支持向量机

7.1 最佳线性分界面
7.2 支持向量分类器
7.3 正则化与再生核 Hilbert 空间简介
7.4 支持向量机(SVM)
7.5 SVM 的算法

8 线性金融时间序列分析及其应用

8.1 资产收益率序列基本统计特征
8.2 AR 模型
8.3 MA 模型
8.4 ARMA 模型

9 条件异方差模型

9.1 波动率的特征与建模问题
9.2 ARCH 模型
9.3 GARCH 模型
9.4 求和 GARCH 模型
9.5 GARCH-M 模型
9.6 指数 GARCH 模型
9.7 门限 GARCH 模型
9.8 CHARMA 模型
9.9 随机系数的自回归模型
9.10 随机波动率模型

10 非线性金融时间序列模型及应用

10.1 双线性模型
10.2 门限自回归模型
10.3 平滑转移 AR 模型
10.4 Markov 转换模型
10.5 非参数建模
10.6 非线性可加 AR 模型
10.7 神经网络模型
10.8 非线性检验

11 极值理论、分位数估计与 VaR

11.1 风险度量制
11.2 VaR 计算的计量经济方法
11.3 分位数估计与回归
11.4 VAR 的极值方法

Statistical Data Analysis

I Course Description

<<Statistical Data Analysis >> is an elective course for the undergraduate students who major in applied mathematics and graduate students who major in applied statistics. It studies the approaches how to collect、arrange、analyze and make inference for the data obtained from various trials in Life Science, Medical Science and Biology and from financial market. This course focuses on: (1) survival analysis, (2) statistical learning, (3) analysis of financial time series. The use of related statistical packages will be demonstrated. The object of this course enables the students to grasp the basic concepts、statistical principle and modeling methods of data analysis and to apply these techniques and the statistical software to analyze and solve relative practical problems.

II Contents

1 Survival Data and Type of Variable

1.1Right censoring

1.2Left censoring and interval censoring

1.3Truncated data

1.4Grouped data

2Basic Function and Parametric Model Basic function of survival analysis

2.1Parametric model for survival dada modelling

2.2Order statistic distribution and extremal distribution

2.3Likelihood function of Censored and truncated data

3Nonparametric methods for estimating basic survival functions

3.1Lifetime table

3.2Estimation for survival function and cumulative mortality function with right censored data

3.3Turnbull estimation

4 Nonparametric Methods for Comparing Survival Function

4.1Comparing between two survival functions
4.2Mantel-Haenszel test in hierarchical case
4.3Comparing among M samples

5 Proportional Hazards Model

5.1Parametric proportional hazards model
5.2Cox semiparametric proportional hazards model

6Neural Networks

6.1Basic characteristics and properties
6.2MP model and Hebb learning rule
6.3Linear threshold unit and Perceptron
6.4Mapping function of multilayer feedforward network
6.5BP networks and BP algorithm
6.6Radical basis function networks

7 Support Vector Machine

7.1Optimal linear interface
7.2SVM classifier
7.3Introduction to regularization and reproducing kernel Hilbert space
7.4Support vector machine
7.5Algorithm for SVM

8 Linear Financial Time Series Analysis and Applications

8.1Basic Statistical characteristics of asset yields
8.2AR model
8.3MA model
8.4ARMA model

9Conditional Heteroskedasticity Model

9.1Characteristics and modeling of volatility
9.2ARCH model

9.3GARCH model

9.4IGARCH model

9.5GARCH-M model

9.6EGARCH model

9.7TGARCH model

9.8CHARMA model

9.9RCA model

9.10SV model

10 Nonlinear Financial Time Series Model and Applications

10.1Bilinear time series model

10.2Threshold Autoregressive model

10.3STAR model

10.4Markov transformation model

10.5Nonparametric modeling

10.6Nonlinear additive AR model

10.7Neural network model

10.8Nonlinear test

11Extreme Theory、Quantile Estimation and VaR RiskMetrics

11.1Econometric method for VaR evaluation

11.2Quantile estimation and regression

11.3Extreme value method of VaR

统计推断与决策

一 基本信息

开课学院（系）和学科：理学院 数学系

课程代码：X071574

课程名称：统计推断与决策

学时/学分：48 学时/3 学分

开课学期：春季

预修课程： 概率论与数理统计

课程主要内容： 统计基本知识、参数点估计、参数假设检验、区间估计和 Bayes 统计推断与决策

适应专业学科： 数学系应用统计专业硕士学位研究生

教材/教学参考书：

【1】范金城，吴可法， 《统计推断导引》，科学出版社，2001

【2】茆诗松、王静龙、 濮晓龙，《高等数理统计》(第二版)， 高等教育出版社和施普林格出版社，2006

【3】G. Casella, R.L. Berger, Statistical inference (Second Edition), DUXBURY THOMSON LEARNING, 2002

二 课程简介

统计推断与决策是数理统计学的核心基础内容，它重点研究如何有效合理地收集、处理带随机性数据并做出科学决策的理论依据。本课程系统地介绍统计推断的基本理论和方法，包括参数点估计，参数假设检验，区间估计，非参数统计推断、Bayes 统计推断与决策等。本课程是在本科《数理统计》基础上的升华，是应用统计专业学位硕士研究生的重要专业基础课程。本课程的学习要求学生初步掌握统计推断的基本理论和方法，培养他们运用统计推断方法分析数据和解决有关实际问题的能力。

三 教学大纲

1 统计基本知识概述

1.1 统计与数理统计；

1.2 样本与样本分布；

1.3 统计量与总体分布；

1.4 充分统计量；

1.5 指数分布族。

2 参数点估计

2.1 估计量及其求法（距估计、最大似然估计）；

2.2 一致最小方差无偏估计（介绍零无偏估计法、Rao-Blackwell 定理、完备统计量）；

2.3 Cramer-Rao 不等式（单参数的 C-R 不等式、优效估计与渐进优效估计）；大样本性质（矩估计、最大似然估计的大样本性质）；

2.4 同变估计（同变估计的概念、最优同变估计、Pitman 估计）

3 参数假设检验

3.1 假设检验概述；

3.2 似然比检验；

3.3 Neyman-Pearson 引理（似然比检验的优良性、随机化试验、Neyman-Pearson 基本引理）；

3.4 一致最大功效检验（检验的最优性、单边假设检验问题的 UMP 检验、指数族分布单边假设检验、UMP 检验不存在的情况）；

3.5 双边假设检验（几个引理、无偏检验、单参数指数族双边假设 UMPU 检验）。

4 区间估计

4.1 区间估计及其求法；

4.2 Neyman 的置信区间（一致最精准（UMA）置信区间、一致最精准无偏（UMAU）置信区间）；

5 非参数统计

5.1 估计的非参数方法

5.2 成对比较检验（符号检验、Wilson 带号秩检验）；

5.3 两总体位置的比较检验（中位数检验法、Wilson 秩和检验）；

5.4 分布拟合检验（Pearson 检验、Kolmogorov 检验）；

6Bayes 统计推断

6.1 先验分布与后验分布；

6.2 Bayes 参数估计；

6.3 Bayes 假设检验

7 统计决策

7.1 统计决策模型

7.2 Bayesian 统计决策（Bayes 解、参数估计的 Bayes 解、参数假设检验的 Bayes 解）

7.3 Minimax 决策

7.4 容许决策

Statistical Inference and Decision

I Course Description

<<Statistical inference and decision>> is the core of mathematical statistics, and its task is to study the theoretical principles about how to efficiently collect and deal with the random data for scientific decision-making. This course systematically introduces the basic theories and methods of statistical inference and decision, including point estimation, hypothesis testing, interval estimation, nonparametric statistical inference, Bayesian statistical inference and decision. This course is a distillation of the undergraduate course "mathematical statistics", and it is also a fundamental course for the postgraduate students major in Applied Statistics.

II Contents

1 Preliminary

1.1Samples and the sample distributions;

1.2Statistics and sampling distributions;

1.3 Sufficient statistics;

1.4 Exponential families.

2 Point estimation

1.1Estimators and methods of finding estimators (the moments estimator, the maximum likelihood estimator);

1.2The uniformly minimum variance unbiased estimator (the method of zero unbiased estimation, Rao-Blackwell theorem, the complete statistics);

1.3Cramer-Rao inequality (single parameter CR inequality, the optimal estimator and the asymptotic optimal estimator);

1.4 The large sample properties of the moment estimator and the maximum likelihood estimator;

1.5 Equivariant estimator

3 Hypothesis testing

3.1 Preliminary;

3.2 Likelihood ratio test;

3.3 Neyman-Pearson lemma (likelihood ratio test of superiority, randomized trial, Neyman-Pearson lemma);

3.4Uniformly most powerful test (the optimal test, UMP test of one-side hypothesis testing problem, one-side hypothesis testing of the exponential family distribution, the case UMP test does not exist);

3.5Bilateral hypothesis test (several lemmas, the unbiased tests; the UMPU test of two-side hypothesis of the single-parameter exponential family).

4 Interval estimation

4.1method for finding the interval estimator;

4.2 Neyman confidence interval (the uniformly most accurate (UMA) confidence interval, the uniformly most accurate unbiased (UMAU) confidence interval);

5 Nonparametric statistics

5.1 Nonparametric estimation methods

5.2Pairwise comparison test (signed test, Wilson with a number of rank test);

5.3 Two overall position comparison test (median test method, Wilson rank sum test);

5.4Distribution Fitting test (Pearson test, Kolmogorov test);

6 Bayesian statistical inference

6.1 Prior distribution and posterior distribution;

6.2 Bayesian parametric estimation;

6.3 Bayesian hypothesis testing

7Statistical Decision

7.1 Statistical Decision Model

7.2 Bayesian statistical decision

(Bayesian solution, Bayesian solution of the parametric estimation, Bayesian solution of the parametric hypothesis test)

7.3Minimax decision

7.4Admissible decision

Syllabus for Time Series Analysis

1. Information

Course code：P071003，MA332

Course name：Time Series Analysis

Credit hours: 48/3

Semester: Spring

Category: Philosophy Master Degree Course in Statistics and Science Master Degree Course in Applied Statistics

Department: Mathematics

Course Nature/Object: Required course / Graduate Student major in Statistics and Applied Statistics

Prerequisite courses: Probability Theory and Mathematical Statistics, Linear Algebra

Textbooks/References

1. Ruey S. Tsay：Analysis of Financial Time Series(Translation)，John Wiley & Sons, Inc.2009。
2. James D. Hamilton，Times Series Analysis，Princeton University Press，1994.
3. Gao TieMei，《Econometric Analysis Methods and Modelling----Eviews’s Applications and Examples》，Tsinghua University Press，2009。
4. Lin Jianzhong，Financial Information Analysis，Shanghai Jiao Tong University Press，Oct.2014

2. Course Description： <<Time Series Analysis >> is a required course for the graduate students who major in statistics and applied statistics. Time series analysis is a statistical method for analyzing the processes of dynamic data. The goal is to find the statistical law of the data by applying the random process theory and mathematical statistical methods, and finally to solve practical problems.

This course mainly introduce the general statistical analysis、statistical modeling、inference and control about time series and financial time series. The object of this course enables the students to grasp the basic concepts、statistical principle and modeling methods of

data analysis and to apply these techniques and the Eviews statistical software to analyze and solve relative practical problems.

3. Contents and Requirements

Chapter 1. Characteristics of Financial Time Series Analysis(3 hours)

1. Yield of asset
2. Distribution properties of asset yield
3. Relative operator of Eviews software

Basic requirements: Grasp the basic concepts and methods. Possess a capability to apply the statistical software to analyze and solve practical problems.

Chapter 2. Linear Time Series Analysis and Applications (12 hours)

1. Stationarity
2. Autocorrelation function
3. AR model
4. MA model
5. ARMA model
6. Unit root processes
7. Regression model with the error of time series
8. Heteroskedasticity consistent covariance estimator
9. Season models
10. Relative operator of Eviews software

Basic requirement: Understand the adaptive scope of these models and analysis principle, possess a capability to apply these techniques and statistical software to analyze and solve practical problems.

Chapter 3. Conditional Heteroskedasticity Model (9 hours)

1. Characteristics and modeling of volatility
2. ARCH model
3. GARCH model
4. IGARCH model
5. GARCH-M model
6. EGARCH model
7. TGARCH model
8. SV model
9. Relative operator of Eviews software

Basic requirements: Understand the adaptive scope of these models and analysis principle, possess a capability to apply these techniques and statistical software to analyze and solve practical problems.

Chapter 4. Nonlinear Financial Time Series Model and Applications (9 hours)

1. Threshold Autoregressive model
2. STAR model
3. Markov transformation model
4. Nonparametric modeling
5. Neural network model
6. Nonlinear test
7. Relative operator of Eviews software

Basic requirements: Understand the adaptive scope of these models and analysis principle, possess a capability to apply these techniques and statistical software to analyze and solve practical problems.

Chapter 5. Extreme Theory、Quantile Estimation and VaR (6 hours)

1. RiskMetrics
2. Econometric method for VaR evaluation
3. Quantile estimation and regression
4. Extreme value method of VaR
5. operator of Eviews software

Basic requirements: Grasp the basic concepts, principles. Possess a capability to apply the statistical software to analyze and solve practical problems.

Chapter 6. Vector Autoregressions and Vector error correction models (9 hours)

1. **Theory on vector autoregressions**
2. **SVAR**
3. **Granger Causality tests for VAR**
4. **The impulse-response function**
5. **Johansen variance decomposition**
6. **Vector error correction models**

4. Statistical Experiment

Require students finish 6 statistical experiments whose tasks include these basic methods in Chapter 1-6 by using Eviews software.

1. **Grading:** Final exam (40%) + 6 statistical experiments with statistical software (60%).

Drafter： Lin Jianzhong
Reviewer： Li Yachun
Nov. 10, 2014

Statistical Learning

I Course Description

Statistical learning refers to a set of tools for modeling and understanding complex datasets. It is a recently developed area in statistics and blends with parallel developments in computer science and, in particular, machine learning. The field encompasses many methods such as the lasso and sparse regression, classification and regression trees, and boosting and support vector machines.

With the explosion of "Big Data" problems, statistical learning has become a very hot field in many scientific areas as well as marketing, finance, and other business disciplines. People with statistical learning skills are in high demand.

This is an introductory-level course in supervised learning, with a focus on regression and classification methods. The syllabus includes: linear and polynomial regression, logistic regression and linear discriminant analysis; cross-validation and the bootstrap, model selection and regularization methods (ridge and lasso); nonlinear models, splines and generalized additive models; tree-based methods, random forests and boosting; support-vector machines. Some unsupervised learning methods are discussed: principal components and clustering (k-means and hierarchical).

This is not a math-heavy class, so we try and describe the methods without heavy reliance on formulas and complex mathematics. We focus on what we consider to be the important elements of modern data analysis. Computing is done in R. There are lectures devoted to R, giving tutorials from the ground up, and progressing with more detailed sessions that implement the techniques in each chapter.

II Contents

1 Introduction

2 Statistical Learning

2.1 What Is Statistical Learning? 2.2 Assessing Model Accuracy 2.3 Lab: Introduction to R

3 Linear Regression

3.1 Simple Linear Regression 3.2 Multiple Linear Regression
3.3 Other Considerations in the Regression Mode 3.4 The Marketing Plan
3.5 Comparison of Linear Regression with K-Nearest Neighbors 3.6 Lab: Linear Regression

4 Classification

4.1 An Overview of Classification 4.2 Why Not Linear Regression? 4.3 Logistic Regression 4.4 Linear Discriminant Analysis 4.5 A Comparison of Classification Methods 4.6 Lab: Logistic Regression, LDA, QDA, and KNN

5 Re-sampling Methods

5.1 Cross-Validation 5.2 The Bootstrap 5.3 Lab: Cross-Validation and the Bootstrap

6 Linear Model Selection and Regularization

6.1 Subset Selection 6.2 Shrinkage Methods 6.3 Dimension Reduction Methods 6.4 Considerations in High Dimensions 6.5 Lab 1: Subset Selection Methods 6.6 Lab 2: Ridge Regression and the Lasso 6.7 Lab 3: PCR and PLS Regression

7 Moving Beyond Linearity

7.1 Polynomial Regression 7.2 Step Functions 7.3 Basis Functions 7.4 Regression Splines 7.5 Smoothing Splines 7.6 Local Regression 7.7 Generalized Additive Models 7.8 Lab: Non-linear Modeling

8 Tree-Based Methods

8.1 The Basics of Decision Trees 8.2 Bagging, Random Forests, Boosting 8.3 Lab: Decision Trees

9 Support Vector Machines

9.1 Maximal Margin Classifier 9.2 Support Vector Classifiers 9.3 Support Vector Machines 9.4 SVMs with More than Two Classes 9.5 Relationship to Logistic Regression 9.6 Lab: Support Vector Machines

10 Unsupervised Learning

10.1 The Challenge of Unsupervised Learning 10.2 Principal Components Analysis 10.3 Clustering Methods 10.4 Lab 1: Principal Components Analysis 10.5 Lab 2: Clustering 10.6 Lab 3: NCI60 Data Example

Statistical Simulation

I Course Description

This course is for graduates studied in statistics. Considering the diversity of students, this course will attempt to introduce a new method of statistical simulation in self-contained way, including new methods, new applications and frontier researches.
In this course, we first show the basic ideas and methods of statistical simulation by a large number of various examples. In particular, we show how to analyze a model by use of a simulation study. we show how a computer can be utilized to generate random (more precisely, pseudorandom) numbers, and then how can be used to generate the values of random variables from arbitrary distributions. This course covers the concerned with Markov chain Monte Carlo methods and its theories, including statistic distribution function simulation, large sample simulation such as Metropolis-Hasting method，Bootstrap, variance reduction techniques. These are techniques that have greatly expanded the use of statistical simulation in recent years. Further, we can deals with some additional topics in statistical simulation, including the Ising model in statistical mechanics and simulated annealing genetic algorithm, risk simulation, random graphs, cellular automata simulation, economic and financial simulation etc.
This course has a special brief introduction to MATLAB software and its programming training.

II Contents

1 Introduction Statistical Simulation
1.1 Simple examples
1.2 Simulation modeling methods and the basic idea
1.3 The Need of Monte Carlo Techniques
1.4 Molecular Structure Simulation

2 Review of probability theory and Statistics
2.1 Intuitive probability
2.2 Understand the probability axioms
2.3 Random variables and probability distributions
2.4 Digital feature random variables - Moments
2.5 Transformation of random variables
2.6 Importance Sampling and Weighted Sample

3 Learn how to use Matlab
3.1 MATLAB Getting Started
3.2 Linear Algebra

3.3 MATLAB mapping function
3.4 Matlab programming
3.5 Matlab symbolic calculus

4 Using Matlab to generate random variables
4.1 Distribution and generate discrete random variables
4.2 Distribution and generate continuous random variables

5 Markov Chain Monte Carlo methods
5.1 Markov Chain and Their Convergence
5.2 MCMC sampling -Metropolis algorithm
5.3 Several examples of MCMC
5.4 Why Metropolis algorithm can work effectively ?

6 Monte Carlo optimization methods
6.1 Simulated Annealing
6.2 Application of the traveling salesman problem simulated annealing method
6.3 Genetic Algorithms
6.4 Maximizing genetic algorithm applied to the function
6.5 Application of Genetic Algorithm in the arrangement in question

7 Random walk
7.1 Diffusion equation
7.2 Brownian motion
7.3 Random Walk in the financial analysis application
7.4 Gamblers bankruptcy analysis

8 Monte Carlo integration
8.1 Random methods for integration
8.2 The sample average method
8.3 Monte Carlo integration method
8.4 importance sampling method

9 The complexity problem simulation
9.1 cellular automata model and applications
9.2 Sznajd model and the social public opinion
9.3 complex networks: random graph, small world and scale-free network
9.4 Bioinformatics: Finding Weak Repetitive Patterns
9.5 Nonlinear Dynamic System: Target Tracking

Review