City University of Hong Kong
Course Syllabus

offered by School of Data Science
with effect from Semester A 2021 / 22

Part I Course Overview

Course Title:	Advanced Statistics
Course Code:	SDSC8004
Course Duration:	One semester
Credit Units:	3
Level:	R8
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
Precursors: *(Course Code and Title)*	Nil
Equivalent Courses: *(Course Code and Title)*	Nil
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

This course aims to provide students with a solid foundation of statistical concepts, theory, and methods including probability theory, statistical estimation and inference methods, and multivariate statistics. It also aims to provide students with a rigorous introduction to the theory and implementation of statistical models such as linear models, generalized linear models, and nonparametric models. Emphasis will be placed on rigorous mathematical derivations, understanding of the fundamentals of statistics but implementation of the statistical methods via computer programming in R or Matlab will be an important part of the course as well.

2. Course Intended Learning Outcomes (CILOs)

No.	CILOs[#]	Weighting	Discovery-enriched curriculum related learning outcomes		
			A1	*A2*	*A3*
1.	Prove and apply various fundamental results in probability theory.	20%	✓	✓	
2.	Understand and implement the techniques of parametric inference such as maximum likelihood estimation and Bayesian inference.	25%	✓	✓	
3.	Understand and derive key results in the theory of linear models and linear model selection.	25%	✓	✓	
4.	Understand and derive key results in the theory of nonparametric statistical models and methods such as the bootstrap method and Gaussian process regression.	20%	✓	✓	
5.	Implement statistical inference methods and modelling methodologies with computer codes.	10%	✓	✓	
		100%			

A1: *Attitude*
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: *Ability*
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to self-life problems.

A3: *Accomplishments*
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

3. Teaching and Learning Activities (TLAs)

TLA	Brief Description	CILO No.					Hours/week
		1	2	3	4	5	
Large Class Activities	Lectures, software training, and in-class exercises	✓	✓	✓	✓	✓	26 hours/semester
Assignments	Exercises provide students with the opportunities to familiarize and apply the statistical tools learnt during the lectures	✓	✓	✓	✓	✓	12 hours/semester

4. Assessment Tasks/Activities (ATs)

Assessment Tasks/Activities	CILO No.					Weighting	Remarks
	1	2	3	4	5		
Continuous Assessment: 75 %							
Midterm Students will be assessed via the midterm their understanding of concepts, theory, and methods learned in class, textbooks, reading materials and their ability to apply subject-related knowledge.	✓	✓	✓	✓		25%	
Two assignments Students will work individually to derive or prove results in probability and statistical theory, and apply statistical methods to analyse data with the help of software.	✓	✓	✓	✓	✓	50%	
Examination: 25 % (duration: 3 Hours)							
Examination Students will be assessed via the examination their understanding of concepts, theory, and methods learned in class, textbooks, reading materials and their ability to apply subject-related knowledge.	✓	✓	✓	✓		25%	
						100%	

5. Assessment Rubrics

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Coursework	Midterm and assignments	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Examination	Examination questions are designed to assess student's level of achievement of the intended learning outcomes. Students will need to demonstrate understanding of various elements of statistical theory and methods taught in the course through precise mathematical exposition.	High	Significant	Moderate	Basic	Not even reaching marginal levels

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus

- Probability theory and distributions (probability space, random variables, expectation, inequalities, and convergence of random variables)
- Parametric statistical inference theory and methods (maximum likelihood estimation, Fisher's scoring, Fisher information, consistency and limiting distribution of maximum likelihood estimators, statistical decision theory, Rao-Blackwell theorem, minimum variance unbiased estimation, Bayesian inference)
- Multivariate statistics (covariance matrix estimation, James-Stein estimator, principle components analysis), linear model theory (least squares, Gauss Markov theorem, ridge regression, leave-one-out cross validation, optimal design of experiments), variable selection methods (Bayesian information criterion, LASSO, LARS).
- Nonparametric statistical models and methods (bootstrap, Gaussian process models, local polynomial regression, kernel methods)

2. Reading List

2.1 Compulsory Readings

1.	Wasserman, L. (2013). *All of statistics: a concise course in statistical inference*. Springer Science & Business Media.
2.	Keener, R. W. (2011). *Theoretical statistics: Topics for a core course*. Springer.
3.	Resnick, S. I. (2013). *A probability path*. Springer Science & Business Media.
4.	Casella, G., & Berger, R. L. (2002). *Statistical inference* (Vol. 2). Pacific Grove, CA: Duxbury.
5.	Rasmussen, C. E., & Williams, C. K. (2006). Gaussian Process Regression for Machine Learning. The MIT Press

2.2 Additional Readings

NIL