City University of Hong Kong
Course Syllabus

offered by School of Data Science
with effect from Semester A 2024/25

Part I Course Overview

Course Title:	Time Series and Recurrent Neural Networks
Course Code:	SDSC6012
Course Duration:	One Semester
Credit Units:	3
Level:	P6
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

In macroeconomics and other areas of business, science, and engineering, a lot of data is available as time series data sets. In this course, students will study the statistical tools that are used to analyse such data and apply them to real world data with the help of the statistical software R. First, students will engage in reviewing basic stochastic process and time series concepts. Then, they will expand their knowledge on ARMA models together with estimation methods for the models and properties of their forecasts, as well as the GARCH model for modelling variation in error variances. Second, students will engage in recurrent neural networks for time series forecast. Throughout the course, students will focus on analysis of data using the taught methods with R software.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	**Describe** AR, MA, ARMA, ARCH GARCH models, and recurrent neural networks for time series data.	20%	✓		
2.	**Apply** time series models to analyse real data using R.	20%	✓	✓	✓
3.	**Explain** model selection criteria for time series models.	20%	✓		
4.	**Apply** the models for time series forecast using R.	20%	✓	✓	
5.	Apply recurrent neural networks to forecast time series data.	20%	✓	✓	✓
		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. Learning and Teaching Activities (LTAs)

(LTAs designed to facilitate students' achievement of the CILOs.)

LTA	Brief Description	CILO No.					Hours/week (if applicable)
		1	2	3	4	5	
Lectures	Students will primarily engage in lectures. Students will participate in mini-lectures and small-group exercises to consolidate their conceptual description and applications of various statistical tools and techniques.	✓	✓	✓	✓	✓	26 hours/semester
Tutorial Exercises	From team-based exercises, students will engage in discussing and applying the statistical tools learnt during the lectures through practical problem solving.		✓		✓	✓	13 hours/semester

4. Assessment Tasks/Activities (ATs)

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks/Activities	CILO No.					Weighting	Remarks
	1	2	3	4	5		
Continuous Assessment: 50 %							
Test		✓	✓	✓	✓	25%	
Assignments	✓	✓	✓	✓		25%	
Examination: 50 % (duration: 2 hours , if applicable)							
Examination	✓	✓	✓	✓	✓	50%	
						100%	

For a student to pass the course, at least 30% of the maximum mark for the examination should be obtained.

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Test	Assess students' conceptual description of statistical methods and recurrent neural networks for time series.	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Assignments	Students' ability to write and employ existing codes in R to analyse real time series data. Explanation and presentation of results are also assessed.	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Examination	Examination questions are designed to assess student's level of achievement of the intended learning outcomes, with emphasis placed on conceptual description and correct application, mostly through mathematical exposition, clear explanation, and numerical calculation, of the various statistical techniques for time series data.	High	Significant	Moderate	Basic	Not even reaching marginal levels

Applicable to students admitted from Semester A 2022/23 to Summer Term 2024

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
1. Test	Assess students' conceptual description of statistical methods and recurrent neural networks for time series and how they can be programmed in R.	High	Moderate	Basic	Not even reaching marginal levels
2. Assignments	Students' ability to write and employ existing codes in R to analyse real time series data. Explanation and presentation of results are also assessed.	High	Moderate	Basic	Not even reaching marginal levels
3. Examination	Examination questions are designed to assess student's level of achievement of the intended learning outcomes, with emphasis placed on conceptual description and correct application, mostly through mathematical exposition, clear explanation, and numerical calculation, of the various statistical techniques for time series data.	High	Moderate	Basic	Not even reaching marginal levels

The midterm, tutorial exercises and laboratory report will be numerically-marked, while examination will be numerically-marked and grades-awarded accordingly.

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

1. Keyword Syllabus

(An indication of the key topics of the course).

- Autoregressive(AR), Moving average(MA), Autoregressive moving average (ARMA) models
- Parameter estimation
- Model selection criteria
- Properties of forecasts
- Modelling volatility using ARCH and GARCH
- Artifical neural networks
- Recurrent neural networks
- Long short-term memory

2. Reading List

2.1 Compulsory Readings

(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

1.	• Shumway, R. H., Stoffer D. S.. (2017). Time Series Analysis and Its Application: with R examples. Springer, 2017.
2.	• Goodfellow, I., Yoshua B., and Aaron C. (2016). Deep learning. MIT press.

2.2 Additional Readings

(Additional references for students to learn to expand their knowledge about the subject.)

1.	• Brockwell, P. J., & Davis, R. A. (2016). Introduction to time series and forecasting. springer.
	• Chollet F., & Allaire J. J. (2018). Deep Learning with R. Manning Publications.