SDSC6012: TIME SERIES AND RECURRENT NEURAL NETWORKS

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Time Series and Recurrent Neural Networks

Subject Code
SDSC - Data Science
Course Number
6012

Academic Unit
Data Science (DS)

College/School
College of Computing (CC)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

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.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe AR, MA, ARMA, ARCH GARCH models, and recurrent neural networks for time series data.	20	x		
2	Apply time series models to analyse real data using R.	20	x	x	x
3	Explain model selection criteria for time series models.	20	x		
4	Apply the models for time series forecast using R.	20	x	x	
5	Apply recurrent neural networks to forecast time series data.	20	x	x	x

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 real-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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	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.	1, 2, 3, 4, 5	26 hours/semester

2	Tutorial Exercises	From team-based exercises, students will engage in discussing and applying the statistical tools learnt during the lectures through practical problem solving.	2, 4, 5	13 hours/semester

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Test	2, 3, 4, 5	25	-	No
2	Assignments	1, 2, 3, 4	25	-	Yes

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

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

Assessment Rubrics (AR)

Assessment Task

Test (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Assess students' conceptual description of statistical methods and recurrent neural networks for time series.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

Assignments (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

Students' ability to write and employ existing codes in R to analyse real time series data. Explanation and presentation of results are also assessed.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

Criterion

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.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task

Test (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion

Assess students' conceptual description of statistical methods and recurrent neural networks for time series and how they can be programmed in R.

Excellent

(A+, A, A-) High

Good
(B+, B) Moderate

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Assignments (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
Students' ability to write and employ existing codes in R to analyse real time series data. Explanation and presentation of results are also assessed.

Excellent
(A+, A, A-) High

Good
(B+, B) Moderate

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Examination (for students admitted from Semester A 2022/23 to Summer Term 2024)

Criterion
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.

Excellent
(A+, A, A-) High

Good
(B+, B) Moderate

Marginal
(B-, C+, C) Basic

Failure
(F) Not even reaching marginal levels

Additional Information for AR

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

Keyword Syllabus

- 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

Reading List

Compulsory Readings

	Title
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.

Additional Readings

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