Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

Expected Implementation in Academic Year	AY2025-2026
Semester/Trimester/Others (specify approx. Start/End date)	Semester 2
Course Author * Faculty proposing/revising the course	Yue Mu
Course Author Email	mu.yue@ntu.edu.sg
Course Title	Data Analysis with Computer
Course Code	MH3511
Academic Units	3
Contact Hours	50
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	MH2500 OR BS1008
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

In today's business, data analysis plays an important role in making decisions more scientific and helping the business achieve effective operation. By closely examining data we can find patterns to perceive information, and the information can be used to enhance knowledge. This course provides basic concepts for data analysis with the usage of the R programming language. You will learn the skills of plotting, summarising, making inferences, and presenting various types of data.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Evaluate the value of Mathematical functions using R. Writing R program to perform a given algorithm.
ILO 2	Distinguish between different types of measurement scales.
ILO 3	Explain the meaning of statistical quantities, such as mean, median, variance, etc., and compute the sample values of a given dataset.
ILO 4	Use R to construct histogram, boxplot, scatterplot, qq-plot, etc.
ILO 5	Construct point and confidence interval estimates for the population parameters using R.
ILO 6	Explain the meaning of Type I and Type II errors, and perform statistical hypothesis testing for various types of dataset.
ILO 7	Perform statistical inference on categorical dataset.
ILO 8	Use parametric methods as an alternative approach to data analysis.
ILO 9	Perform linear regression and check for model assumptions.

Course Content

Basic of R programming • Basic R syntax • Write mathematical expression in R language • Variable, vector, matrix and dataframe, and their operations in R • Importing dataset into R, subsetting dataset • Basic loops in R

Describing Data • Basic parameters such as mean, median, standard deviation, variance, inter- quartile range • Boxplot, histogram, stem-leaf plot • Normality checks, qq-plot, outlier, transformation

Statistical Inference • Sample, sampling distribution • Central Limit Theorem • Confidence Interval • Statistical hypothesis testing, Type I and Type II errors, p-value

Categorical Data • Proportion estimate, testing of proportion parameter • Goodness-of-fit test • Two-way contingency table • Paired 2-way contingency table

Multiple Samples • Two independent samples, inference on mean difference • Two dependent samples • Multiple (>2) independent samples, ANOVA test • Multiple (>2) dependent samples

Nonparametric Tests • Quantile test • Wilcoxon rank-sum test • Kruskal-Wallies Test • Sign test, Wilcoxon signed-rank test • Friedman test

Correlation and Regression • Correlation coefficient, its confidence interval and statistical test • Simple linear regression model • Inference on the parameters of linear model • Prediction inference • Model checking

Reading and References (if applicable)

1. Hothorn & Everitt: A Handbook of Statistical Analysis Using R, 3rd Edition, CRC Press 2014. ISBN-10: 1482204584, ISBN-13: 978-1482204582
2. Michael J. Crawley: Statistics, An Introduction using R, Wiley 2005. ISBN-10: 0470022981, ISBN-13: 978-0470022986

NOTE: The above listing comprises the foundational readings for the course and more up-to-date relevant readings will be provided when they are available.

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Basic of R programming • Basic R syntax • Write mathematical expression in R language • Variable, vector, matrix and dataframe, and their operations in R	1	Lecture notes	In-person	
2	Basic of R programming • Importing dataset into R, subsetting dataset • Basic loops in R	1	Lecture notes	In-person	Lab Assignment + Wooclap in-class activity
3	Describing Data • Basic parameters such as mean, median, standard deviation, variance, inter-quartile range • Boxplot, histogram, stem-leaf plot • Normality checks, qq-plot, outlier, transformation	2, 3, 4	Lecture notes	In-person	Lab Assignment + Wooclap in-class activity

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
4	Statistical Inference • Sample, sampling distribution • Central Limit Theorem • Confidence Interval •	5, 6, 7	Lecture notes	In-person	Lab Assignment + Wooclap in-class activity
5	Statistical Inference • Statistical hypothesis testing, Type I and Type II errors, p- value	5, 6, 7	Lecture notes	In-person	Lab Assignment + Wooclap in-class activity
6	Categorical Data • Proportion estimate, testing of proportion parameter • Goodness-of-fit test	5, 6, 7	Lecture notes	In-person	Lab Assignment + Wooclap in-class activity
7	Categorical Data • Two-way contingency table • Paired 2-way contingency table	5, 6, 7	Lecture notes	In-person	Lab Assignment + Wooclap in-class activity + Midterm Quiz 1
8	Multiple Samples • Two independent samples, inference on mean difference • Two dependent samples	5, 6, 7	Lecture notes	In-person	Lab Assignment + Wooclap in-class activity

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
9	Multiple Samples • Multiple (>2) independent samples, ANOVA test • Multiple (>2) dependent samples	5, 6, 7	Lecture notes	In-person	Lab Assignment + Wooclap in-class activity
10	Nonparametric Tests • Quantile test • Wilcoxon rank-sum test • Kruskal-Wallies Test	5, 6, 8	Lecture notes	In-person	Lab Assignment + Wooclap in-class activity + Midterm Quiz 2
11	Nonparametric Tests • Sign test, Wilcoxon signed-rank test • Friedman test	5, 6, 8	Lecture notes	In-person	Lab Assignment + Wooclap in-class activity
12	Correlation and Regression • Correlation coefficient, its confidence interval and statistical test • Simple linear regression model	5, 6, 9	Lecture notes	In-person	Lab Assignment + Wooclap in-class activity
13	Correlation and Regression • Inference on the parameters of linear model • Prediction inference • Model checking	5, 6, 9	Lecture notes	In-person	Lab Assignment + Wooclap in-class activity

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	This is intended to help you understand the motivation and definitions of the concepts and notions, approaches to solving problems in pursuant to learning outcomes.
Laboratories	This will help to develop your problem solving and computing skills, reinforce the understanding of the concepts and notions.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Report/Case study(Written Report)	1, 2, 3, 4, 5, 6, 7, 8, 9		15	Students will form groups of five to collaboratively prepare and submit a project report.	Team	Holistic	Not Applicable
2	Continuous Assessment (CA): Test/Quiz(Short Answer Questions 1)	1, 2, 3, 4		15	A 1-hour quiz consisting of short-answer questions designed to assess students' understanding of the course material.	Individual	Analytic	Not Applicable
3	Continuous Assessment (CA): Test/Quiz(Short Answer Questions 2)	5, 6, 7		15	A 1-hour quiz consisting of short-answer questions designed to assess students' understanding of the course material.	Individual	Analytic	Not Applicable
4	Summative Assessment (EXAM): Final exam(MCQs & Short Answer Questions)	1, 2, 3, 4, 5, 6, 7, 8, 9		50	A 2-hour exam designed to assess students' understanding of the course material.	Individual	Analytic	Not Applicable

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
5	Continuous Assessment (CA): Class Participation(Tracked via Wooclap during lab sessions.)			5	Class participation is tracked via Wooclap during lab sessions. Completing at least 8 sessions earns full participation marks (5%), while 6–7 sessions earns partial participation (3%).	Individual	Holistic	Not Applicable

Description of Assessment Components (if applicable)

Formative Feedback

For midterm Quizzes: Feedback on common mistakes and the level of difficulty of the problems will be given. For Project (Written Report): You will receive individual written and/or verbal feedback about their project. For Final Exam: the Examiner's Report will be provided.

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Communication	Basic
Decision Making	Intermediate
People Orientation	Basic
Information Literacy	Intermediate
Critical Thinking	Intermediate

Course Policy

Policy (Academic Integrity)

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values. As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

You are expected to complete all lab assignments, take the quizzes, and complete the project (written report). You are expected to take responsibility to follow up with course notes, assignments and course related announcements if you are absent.

Policy (Absenteeism)

Absence from quizzes and examination without a valid reason will affect your overall course grade. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies.

(3) Absence Due to Medical or Other Reasons

If you are sick and not able to attend the midterm, you have to submit the original Medical Certificate (or another relevant document) to the administration to obtain official leave. In this case, the missed assessment component will not be counted towards the final grade. There are no make-up midterm.

Policy (Others, if applicable)

Diversity and inclusion policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science.

It is our goal to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences, and that honours your identities; including ethnicity, gender, socioeconomic status, sexual orientation, religion or ability.

To help accomplish this:

- If you are neuroatypical or neurodiverse, have dyslexia or ADHD (for example), or have a social anxiety disorder or social phobia;
- If you feel like your performance in the class is being impacted by your experiences outside of class;

- If something was said in class (by anyone, including the instructor) that made you feel uncomfortable;

Please speak to your teaching team, our school pastoral officer or a peer or senior (either in-person or via email) about how we can help facilitate your learning experience.

As a participant in course discussions, you should also strive to honour the diversity of your classmates. You can do this by: using preferred pronouns and names; being respectful of others opinions and actively making sure all voices are being heard; and refraining from the use of derogatory or demeaning speech or actions.

All members of the class are expected to adhere to the NTU anti-harassment policy. if you witness something that goes against this or have any other concerns, please speak to your instructors or a faculty member.

Appendix 1: Assessment Rubrics

Rubric for Laboratories: Written Report (15%)

Criteria	Standards		
	Fail standard	**Pass standard**	**High standard**
Methods of approach	Using methods that are irrelevant or do not apply to the given problem. Invoking theorems whose conditions are not satisfied.	Using relevant methods that help solve the problem. Invoking theorems whose conditions are satisfied.	Finding methods and utilizing theorems that are both relevant and effective
Validity of reasoning	Reasoning is logically invalid.	Reasoning is logically valid.	Reasoning is logically valid and effective.
Clarity of argument	Reasoning is poorly explained or not explained at all.	Reasoning is clear but may contain some gaps.	Reasoning is clear, precise with no or insignificant gaps.

Rubric for Mid-semester Quiz: Short Answer Questions 1 (15%)

Criteria	Standards		
	Fail standard	**Pass standard**	**High standard**
Methods of approach	Using methods that are irrelevant or do not apply to the given problem. Invoking theorems whose conditions are not satisfied.	Using relevant methods that help solve the problem. Invoking theorems whose conditions are satisfied.	Finding methods and utilizing theorems that are both relevant and effective
Validity of reasoning	Reasoning is logically invalid.	Reasoning is logically valid.	Reasoning is logically valid and effective.
Clarity of argument	Reasoning is poorly explained or not explained at all.	Reasoning is clear but may contain some gaps.	Reasoning is clear, precise with no or insignificant gaps.

Rubric for Mid-semester Quiz: Short Answer Questions 2 (15%)

Criteria	Standards

	Fail standard	Pass standard	High standard
Methods of approach	Using methods that are irrelevant or do not apply to the given problem. Invoking theorems whose conditions are not satisfied.	Using relevant methods that help solve the problem. Invoking theorems whose conditions are satisfied.	Finding methods and utilizing theorems that are both relevant and effective
Validity of reasoning	Reasoning is logically invalid.	Reasoning is logically valid.	Reasoning is logically valid and effective.
Clarity of argument	Reasoning is poorly explained or not explained at all.	Reasoning is clear but may contain some gaps.	Reasoning is clear, precise with no or insignificant gaps.

Rubric for Examination: Short Answer Questions (50%)

Criteria	Standards		
	Fail standard	Pass standard	High standard
Methods of approach	Using methods that are irrelevant or do not apply to the given problem. Invoking theorems whose conditions are not satisfied.	Using relevant methods that help solve the problem. Invoking theorems whose conditions are satisfied.	Finding methods and utilizing theorems that are both relevant and effective
Validity of reasoning	Reasoning is logically invalid.	Reasoning is logically valid.	Reasoning is logically valid and effective.
Clarity of argument	Reasoning is poorly explained or not explained at all.	Reasoning is clear but may contain some gaps.	Reasoning is clear, precise with no or insignificant gaps.

Rubric for Class Participation (5%)

Class participation is tracked via Wooclap during lab sessions. Completing at least 8 sessions earns full participation marks (5%), while 6–7 sessions earns partial participation (3%).