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

Course Overview

The sections shown on this interface are based on the templates UG OBTL+ or PG OBTL+
If you are revising/duplicating an existing course and do not see the pre-filled contents you expect in the subsequent sections e.g. Course Aims, Intended Learning Outcomes etc. please refer to Data Transformation Status for more information.

Expected Implementation in Academic Year	2024-2025
Semester/Trimester/Others (specify approx. Start/End date)	Semester 2
Course Author * Faculty proposing/revising the course	Nicolas Privault
Course Author Email	nprivault@ntu.edu.sg
Course Title	Spatial data science
Course Code	MH4522
Academic Units	4
Contact Hours	51
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	MH2500 Probability and Introduction to Statistics
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

Spatial data science is a timely topic which has been quickly evolving in recent years, and is rich in applications. This course addresses current needs for the statistical modeling of random patterns and structures in spatial contexts, which arise in multiple fields ranging from geophysical, life and earth sciences, to communication engineering and social network analysis.

The course approach relies on computational and statistical tools from stochastic geometry, which is the study of random sets and structures in one or higher dimensions. The course is mainly addressed to undergraduate students in mathematics and statistics, and can also benefit science and engineering students possessing a quantitative background.

Course's Intended Learning Outcomes (ILOs)

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

ILO 1	Model spatial data using point processes
ILO 2	Analyze the connectivity of random graph models
ILO 3	Estimate the statistics of large scale random networks
ILO 4	Perform relevant random simulations
ILO 5	Apply the course concepts to real life situations

Course Content

1. Spatial point processes

2. Modeling spatial data

3. Modeling random shapes

4. Random graph models

5. Statistics of random structures

6. Connectivity estimates

7. Large scale random networks

8. Viral dynamics on networks

Reading and References (if applicable)

A. Frieze and M. Karonski, Random Graphs and Networks: A First Course, Cambridge University Press, 2023, ISBN: 978-1-009-26030-5

S. Roch, Modern Discrete Probability - An Essential Toolkit, Cambridge University Press, 2023, ISBN: 9781009305129

Note: The above readings comprise 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	Introduction and motivations	1,2,3,4,5	Lecture notes	In-person	
2	Probability background	1,2,3,4,5	Lecture notes	In-person	
3	Poisson point processes	1,4,5	Lecture notes	In-person	Assignment and simulations
4	Interacting point processes	1,4,5	Lecture notes	In-person	Assignment and simulations
5	Self-exciting point processes	1,4,5	Lecture notes	In-person	Assignment and simulations
6	Boolean model	1,4,5	Lecture notes	In-person	Assignments and simulations
7	Random Graph Models	2,4,5	Lecture notes	In-person	Assignment and simulations
8	Midterm Test	1,2,5		In-person	In-class test
9	Random-connection model	2,4,5	Lecture notes	In-person	Assignment and simulations
10	Connectivity properties	2,3,4,5	Lecture notes	In-person	Assignment and simulations
11	Large scale random graphs	2,3,4,5	Lecture notes	In-person	Assignment and simulations
12	Viral dynamics on random networks	2,3,4,5	Lecture notes	In-person	Assignment and simulations

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
13	Revisions and additional tutorial exercises	1,2,3,4,5	Lecture notes	In-person	Exercises

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures and tutorials	Derivation and demonstration: Explain the motivation behind mathematical notions and ideas. Present systematic ways to solve problems related to the concepts developed. Derive important formulas that are fundamental.
Computer based simulations	This will allow you to develop realistic solutions to complex problems and will facilitate creative problem solving.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Assignment(Written take home assignment)	1,2,3,4,5		20	Individual	Holistic	Multistructural
2	Continuous Assessment (CA): Test/Quiz(Midterm test)	1,2,3,5		20	Individual	Analytic	Relational
3	Summative Assessment (EXAM): Final exam(Final exam)	1,2,3,5		60	Individual	Analytic	Multistructural

Description of Assessment Components (if applicable)

The written take home assignment will consider an application of point processes to data science, and will require the student to perform mathematical derivations and to write detailed proofs. The midterm test will be designed to check the student understanding of course concepts.

Formative Feedback

You will receive formative feedback through written responses to your tests/assignments and verbal feedback through in-class discussion.

NTU Graduate Attributes/Competency Mapping

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

Attributes/Competency	Level
Communication	Intermediate
Curiosity	Advanced
Critical Thinking	Advanced

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 assigned readings, activities, assignments, attend all classes punctually and complete all scheduled assignments by due dates. You are expected to take responsibility to follow up with assignments and course related announcements. You are expected to participate in all project critiques, class discussions and activities.

Policy (Absenteeism)

In-class activities make up a significant portion of your course grade. Absence from class without a valid reason will affect your participation 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. There will be no make-up opportunities for in-class activities.

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.

Point-based marking (not rubric-based)