JOHNS HOPKINS
WHITING SCHOOL
of ENGINEERING

Applied Mathematics and Statistics 553.726
Point Processes and Stochastic Geometry
Fall 2025

Instructor

Professor Eliza O'Reilly, eoreill2@jh.edu
Office: Wyman Park Building N429
Office hours: Wednesdays 1-3pm Wyman N461

Teaching Assistant

Jiahui Li, jli406@jhu.edu
Office hours: Tuesdays 3-5pm, Wyman S425

Meetings

Lectures: Monday and Wednesday 9am–10:15am, Wyman N425

Textbook References

There is no required textbook for the course. The class material will be drawn mainly from the following texts:

- Gunter Last and Mathew Penrose, Lectures on the Poisson Process, Cambridge University Press, 2017.
- François Baccelli, Bartłomiej Błaszczyszyn, Mohamed Karray. Random Measures, Point Processes, and Stochastic Geometry. Inria, 2020.
- R. Schneider and W. Weil, Stochastic and Integral Geometry, Springer Verlag, 2008.
- D.J. Daley and David Vere-Jones. An Introduction to the Theory of Point Processes, Probability and Its Applications, Springer, 2008.
- D. Stoyan, W. Kendall & J. Mecke, Stochastic Geometry and its Applications, John Wiley and Sons, second edition, 1995.

Online Resources

Please log in to Canvas for online information related to this course.

Course Information

Point processes are fundamental models in probability that are crucial to the field of stochastic geometry- the study of random geometric objects and patterns. The first part of the course will cover point processes in Euclidean space and we will discuss Poisson point processes as well as models with interaction between points including clustering and regularity. The second part of the course will provide the mathematical foundation for standard stochastic geometric models: random closed sets, particle processes, and random mosaics. These models have found numerous applications in physics, biology, chemistry, and data science. One main goal of the course is to provide the ability and encouragement for students to find new applications of these models and/or use the theory to build new models in their research area.

Learning Outcomes

By the end of this course, you will...

- understand how to define/simulate and describe the distribution of point
- processes
- have mastered the definitions of basic stochastic geometric models
- understand how to compute their law
- have studied an application of point processes or stochastic geometric modeling
- be equipped to find new applications of the theory of point processes and stochastic geometric modeling

Course Topics

The following is a list of topics we will cover in this course.

- Definition of point processes
- How to describe the distribution of a point process
- Poisson processes (on general spaces)
- Transformations of Poisson processes
- Stationarity and the Palm distribution
- Slivnyak-Mecke Theorem and Doubly Stochastic Poisson processes
- Janossy measures and Gibbs point processes
- Determinantal Point processes
- Random Closed Sets
- Set Processes and Particle Processes
- Germ-grain processes
- Random Voronoi Tessellations
- Processes of Flats
- Poisson Hyperplane Tessellations
- Stable under Iteration Tessellations

Course Expectations & Grading

There will be graded homework assignments every two weeks, as well as a final project with a written and in-class presentation component. A portion of the grade will also reflect participation which includes completion of two surveys (beginning of semester and mid-semester). We highly encourage students to attend all live lectures and TA sessions.

If you cannot attend lecture for any reason, a recording and notes for each lecture will be posted to Canvas the same day and you are highly encouraged to read these and ask any questions you have on the covered material by email or in office hours before the next lecture.

The **grading breakdown** for the course will be:
Homework: 40%
Participation: 20%
Final Project: 40%

Assignments

- Homework assignments will be announced in class and posted to Canvas, and they will be due every other Wednesday **by 11:59pm**
- *No late homework will be accepted*, but the lowest HW grade will be dropped.
- Homework solutions will be put on Canvas shortly after the homework is due

Key Dates (NOTE: Dates are subject to change.)

There will be no class on Labor Day (Monday, September) 1.

Final Project Proposals will be due (by email) 5pm Monday, October 27.

Final Project Presentations will take place the week of November 17 and December 1.

There will be no class the week of fall recess, November 24-28.

The last lecture for the course will be held Wednesday, December 3.

Final Project Reports will be due 11:59pm Friday December 5.

For other key dates, see https://registrar.jhu.edu/academic-calendar/

Disability Services

Johns Hopkins University values diversity and inclusion. We are committed to providing welcoming, equitable, and accessible educational experiences for all students. Students with disabilities (including those with psychological conditions, medical conditions, and temporary disabilities) can request accommodations for this course by providing an Accommodation Letter issued by Student Disability Services (SDS). Please request accommodations for this course by reaching out directly to the instructor as early as possible to provide time for effective communication and arrangements.

For further information or to start the process of requesting accommodations, please contact Student Disability Services at Homewood Campus, Shaffer Hall #101, call: 410-516-4720 and email: studentdisabilityservices@jhu.edu or visit the website.

Academic Integrity

The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition.

Report any violations you witness to the instructor. You can also contact:

- For undergraduates: the associate dean of student conduct (or designee) by calling the Office of the Dean of Student Life at 410-516-8208 or via email at studentconduct@jhu.edu
- For KSAS Graduate Students: rseitz5@jh.edu
- For WSE Graduate Students: christinekavanagh@jhu.edu

You can find more information about university misconduct policies on the web at these sites:

- For undergraduates: http://e-catalog.jhu.edu/undergrad-students/student-life-policies/
- For graduate students: http://e-catalog.jhu.edu/grad-students/graduate-specific-policies/

In addition, the specific academic integrity policies for this course are:

- You may (and are encouraged to) collaborate on homework problems with classmates, but you must write up your own solutions without looking at another student's written solutions.

Mental Health Statement

HU has several resources to support students. Many students struggle with stress at times with stress, anxiety, and depression. The Counseling Center has many resources available to students:

Johns Hopkins University Student Well-Being (jhu.edu)

In addition, The Johns Hopkins University Behavioral Health Crisis Support Team (BHCST) pairs experienced, compassionate crisis clinicians with specially trained public safety officers on every shift on and around the Homewood campus, seven days a week. The BHCST will provide immediate assistance to those who need it and, just as importantly, link individuals in crisis to ongoing support services in the days and weeks that follow. Call Public Safety, 410-516-5600, and ask for a BHCST clinician.

If you have concerns about a specific student, please contact:

- For emergencies (threat to self or others): 410-516-4600 or 911
- For on-scene mental health support: BHCST at 410-516-4600
- For undergraduates: Student Outreach & Support at 410-516-7857 or studentoutreach@jhu.edu (undergraduates)
- For KSAS Graduate Students: Renee Eastwood, Assistant Dean for Graduate and Postdoctoral Academic and Student Affairs
- For WSE Graduate Students: Megan Barrett, Assistant Dean for Engineering Student Affairs

Inclusivity

Johns Hopkins University is committed to creating a classroom environment that values the diversity of experiences and perspectives that all students bring. Everyone here has the right to be treated with dignity and respect. Fostering an inclusive climate is important because research and experience show that students who interact with peers who are different from themselves learn new things and experience tangible educational outcomes. Please join us in creating a welcoming and vibrant classroom climate. Note that you should expect to be challenged intellectually by the instructor,

the TAs, and your peers, and at times this may feel uncomfortable. Indeed, it can be helpful to be pushed sometimes in order to learn and grow. But at no time in this learning process should someone be singled out or treated unequally on the basis of any seen or unseen part of their identity.

If you ever have concerns in this course about harassment, discrimination, or any unequal treatment, or if you seek accommodations or resources, please reach out to your instructor or the TAs who will take your communication seriously and will seek mutually acceptable resolutions and accommodations. Reporting will never impact your course grade. You may also share concerns with the department chair, the Director of Undergraduate Studies (WSE Department Heads and DUSes), the WSE Assistant Dean for Diversity and Inclusion (Darlene Saporu, dsaporu@jhu.edu), the KSAS Assistant Dean for Diversity and Inclusion (Araceli Frias, afrias3@jhu.edu) or the Office of Institutional Equity (oie@jhu.edu). In handling reports, people will protect your privacy as much as possible, but faculty and staff are required to officially report information for some cases (e.g., sexual harassment).

Classroom Climate

As instructor, I am committed to creating a classroom environment that values the diversity of experiences and perspectives that all students bring. Everyone in the course has the right to be treated with dignity and respect. I believe fostering an inclusive climate is important because research and my experience show that students who interact with peers who are different from themselves learn new things and experience tangible educational outcomes. Please join me in creating a welcoming and vibrant classroom climate. Note that you should expect to be challenged intellectually by me, the TAs, and your peers, and at times this may feel uncomfortable. Indeed, it can be helpful to be pushed sometimes in order to learn and grow. But at no time in this learning process should someone be singled out or treated unequally on the basis of any seen or unseen part of their identity.

If you ever have concerns in this course about harassment, discrimination, or any unequal treatment, or if you seek accommodations or resources, I invite you to share your concerns directly with me or the Teaching Assistants. I promise that we will take your communication seriously and seek mutually acceptable resolutions and accommodations. Reporting will never impact your course grade. You may also share concerns with the Applied Mathematics and Statistics (AMS) Department Head (Professor Fadil Santosa, mailto:fsantos9), the AMS Associate Head and Director of Graduate Studies (Professor Daniel Naiman, mailto:daniel.naiman@jhu.edu), the AMS Director of Undergraduate Studies (Professor Donniell Fishkind, mailto:dfishki1@jhu.edu) the Assistant Dean for Diversity and Inclusion (Darlene Saporu, mailto:dsaporu@jhu.edu), or the Office of Institutional Equity (mailto:oie@jhu.edu). In handling reports, people will protect your privacy as much as

possible, but faculty and staff are required to officially report information for some cases (e.g., for sexual harassment).