THE UNIVERSITY OF BRITISH COLUMBIA

Irving K. Barber Faculty of Science
Okanagan Campus

Department of Computer Science, Mathematics, Physics and Statistics

Stat 403 Section 001
Stochastic Processes
2020 Winter Term 1

Instructor:
Name: Eric Foxall (he, him).
You can address me as Eric, Dr. Foxall, professor, whatever is comfortable for you.
Office: not on campus – contact me by e-mail.
Email: efoxall@mail.ubc.ca

Office Hours: Mon 11am-12pm on Canvas Collaborate Ultra, and by appointment.

Note: Collaborate Ultra is an audio-video recording/interaction tool that can be accessed by signing into this course on Canvas. From the main course page it can be found on the left-hand menu bar (you may have to scroll down a bit).

Course Description:

Stat 403 (3) Stochastic Processes
Random walks, Markov chains, Poisson processes, continuous time Markov chains, birth and death processes, exponential models, and applications of Markov chains. [3-0-0]
Prerequisite: STAT 303.

Course Format:

Lecture schedule: Mon 2:30-4pm, Thur 3:30-5pm

One of our lectures (dates below under “Course Evaluation”) will be reserved for a midterm. For students in time zones for which lecture times fall in the middle of the night, please get in touch with me for alternate arrangements for midterm writing, if needed.

Lecture access: online on Canvas, under the Collaborate Ultra tab.

Will lectures be recorded? Yes, all lectures will be recorded. I’ll also post lecture notes. Find the recorded lectures on Collaborate Ultra (they will be numbered) and the notes in a module on Canvas.

Midterm break and other important calendar dates can be found at http://okanagan.students.ubc.ca/calendar/

Learning Outcomes: After completing this course, you will be able to:

• Understand and describe stochastic processes mathematically as both
1. a collection of time-indexed random variables on a common sample space, and
2. a random trajectory, or sample path, through a given state space.

• Understand the notion of an i.i.d. (independent and identically distributed) sequence of random variables.
• Study certain processes associated to i.i.d. sequences, such as record values for non-negative random variables, and runs of 1s for bernoulli random variables.
• Construct a random walk from an i.i.d. sequence of real-valued random variables.
• Define Markov chains in discrete time using transition probabilities, and in continuous time using transition rates.
• Construct a Markov chain model, based on a given description.
• Verify the Markov property for a given process.
• Compute the probability distribution for the location of a Markov chain at a given fixed time, using the Chapman-Kolmogorov (discrete time) or forward/backward Kolmogorov (continuous-time) equations.
• Define stopping times and understand the strong Markov property.
• Determine the communicating classes of a Markov chain from its transition probabilities/rates and use these to describe its long-term behaviour.
• Understand the phenomenon of periodicity in a discrete time Markov chain.
• Use conditioning and first-step analysis to obtain and solve sets of equations describing important objects associated to Markov chains, such as the hitting probability and expected hitting time of a set, and stationary distributions, when they exist.
• Understand the notions of recurrence and transience of a stochastic process. Determine the recurrence or transience of various random walks.

• Construct and analyze various models in discrete and/or continuous time and study their characteristic properties, such as:

1. branching processes and their survival probability and asymptotic rate of growth,
2. the radioactive decay model, and the time until complete decay,
3. the ehrenfest urn model and its stationary distribution,
4. queuing models, existence or non-existence of a stationary distribution and expected wait times,
5. general birth and death processes, probability of divergence, hitting times and stationary distributions,
6. the basic insurance model and the ruin probability,
7. the Moran model of population genetics, and its probability of fixation and expected time until fixation,
8. the stochastic SIR model of infection spread in a finite population, and its final size.

• Understand the connection between discrete time and continuous time Markov chains obtained by the embedded Markov chain.
• Construct a Markov chain mathematically:
    1. from an i.i.d. collection of uniform random variables, in discrete time, and
    2. from an i.i.d. collection of exponential random variables, and an i.i.d. collection of uniform random variables, in continuous time.

• Use the technique of coupling to study the convergence of a Markov chain to its stationary distribution, when one exists.

• Construct and analyze the Poisson point process and the corresponding counting process, the Poisson process. Understand its relationship with exponential random variables and with i.i.d. uniform random variables.

Passing Criteria: a grade of 50% or more will constitute a passing grade for this course. It represents at least a partial working knowledge of the topics covered.

Required Materials:

The following textbook is optional:

Introduction to Probability Models, Sheldon M. Ross

I believe the current edition is number 12 although not much has changed; I am using the 9th edition. The above textbook is a good reference as a first introduction to stochastic processes and Markov chains; for this course, it will truly be optional, but it does contain a lot of nice examples and exercises. If you are unable to find a copy of a suitable edition online or elsewhere, you can buy a physical or electronic copy from the bookstore. Here are some other good references that cover much of the same material as our course; the first two are freely available online from the authors' websites:

Lecture Notes on Stochastic Processes with Applications in Biology, David F. Anderson
http://u.math.biu.ac.il/~amirgi/SBA.pdf

Essentials of Stochastic Processes, Rick Durrett
https://services.math.duke.edu/~rtd/EOSP/EOSP2E.pdf

An Introduction to Stochastic Modelling, H.M. Taylor and S. Karlin.

Course Evaluation:

Evaluation will consist of the following components:

Assignments (5 total)	40%	See below
Midterm	20%	Oct 22
Conversational assessment	5%	TBA
Final project outline	5%	Oct 29
Final project report	20%	Nov 27
Final project presentation	10%	Last week of class
Total	100%	

Assignments: Assignments will be due on weeks 2,4,6,9 and 11, on Thursdays at 11pm Pacific Daylight Time. So, assignment due dates will be Sep 17, Oct 1, Oct 15, Nov 5 and Nov 19. Assignments will be available on Canvas at least one week ahead of the due date and will be submitted on Canvas by uploading your work.

Midterm: the midterm will take place during lecture time (3:30-5pm) on the Thursday listed above. The midterm will become available on Canvas at 3:30pm and you will have 80 minutes to write your midterm. An extra 20 minutes (4:50-5:10pm) will be reserved to give you time to scan/photograph and upload your work to Canvas.

Conversational assessment: this segment is an opportunity to practice communicating your work. After one of your homework assignments is returned, we will schedule a short (5 minute) conversation slot (to occur on Collaborate Ultra) in which I will ask you to go over and explain a question from your assignment/test, chosen at random from the problems that you completed (or attempted, if no problems were completed). I have not yet scheduled dates for this component -- I will provide notice of at least one week before it occurs.

Formats for online submissions: please ensure you can upload your work in an easily recognizable file format, such as .pdf, .jpg or .jpeg, and .png. Please avoid formats such as .HEIC (default image file type for certain phones) as these need to be individually converted before they can be read. There are many apps you can use to convert image files of arbitrary formats into one of the three recommended formats above. This will help save time when grading your work and is much appreciated.

Final project: instead of a final exam, subject to your approval, we will have a final project. The reason your approval is needed is because the final presentations would occur during the last week of class, and there is a Senate policy that says students are not required to undergo any tests or major assessments during the last two weeks of class. Note that if we do a final project, there will be no final exam. The final project will consist of a report and presentation on a topic of your choice related to stochastic processes, preferably related, or building upon, the topics we studied during the course. I will give you a list of topics from which you can select, or you can choose your own topic.

Final grades will be based on the evaluations listed above and the final grade will be assigned according to the standardized grading system outlined in the UBC Okanagan Calendar.

Note: Any requests for changes to final exams must be sent to the office of the Associate Dean of Students (bsasdeansoffice.ubco@ubc.ca).

Missed Assignments and Exams (if applicable)

If you think you might miss an assignment or a test, please *get in touch with me right away!* It may not be guaranteed to have it omitted, but it's much easier to sort it out if you tell me before the due date. See the link in the paragraph below for an explanation of the valid reasons for which you can have an assignment or a test omitted (with the weight shifted to the remainder of your evaluated material).

If ill health is an issue, students are encouraged to seek attention from a health professional. Campus Health and Counselling will normally provide documentation only to students who have been seen previously at these offices for treatment or counselling specific to conditions associated with their academic difficulties. Students who feel that requests for consideration have not been dealt with fairly by their instructors may take their concerns first to the Head of the discipline, and if not resolved, to the Office of the Dean. Further information can be found at: http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,48,0,0.

Late Policy

Except in cases of academic concessions (see link above), no late assignments will be accepted. With this in mind, please ensure that you leave yourself enough time to scan/photograph and upload your assignments before the deadline.

Outline of Lectures

An outline of the lecture schedule and topics will be posted on Canvas sometime before the first day of class.

Note: the remainder of this outline consists of standard material that you should find on every course outline

Copyright Disclaimer Diagrams and figures included in lecture presentations adhere to Copyright Guidelines for UBC Faculty, Staff and Students http://copyright.ubc.ca/requirements/copyright-guidelines/ and UBC Fair Dealing Requirements for Faculty and Staff http://copyright.ubc.ca/requirements/fair-dealing/. Some of these figures and images are subject to copyright and will not be posted to ***Connect***. All material uploaded to ***Connect*** that contain diagrams and figures are used with permission of the publisher; are in the public domain; are licensed by Creative Commons; meet the permitted terms of use of UBC's library license agreements for electronic items; and/or adhere to the UBC Fair Dealing

Requirements for Faculty and Staff. Access to the ***Connect*** course site is limited to students currently registered in this course. Under no circumstance are students permitted to provide any other person with means to access this material. Anyone violating these restrictions may be subject to legal action. Permission to electronically record any course materials must be granted by the instructor. Distribution of this material to a third party is forbidden.

Grievances and Complaints Procedures

A student who has a complaint related to this course should follow the procedures summarized below:

- The student should attempt to resolve the matter with the instructor first. Students may talk first to someone other than the instructor if they do not feel, for whatever reason, that they can directly approach the instructor.
- If the complaint is not resolved to the student's satisfaction, the student should go to the departmental chair John Braun at SCI 388, 807-8032 or e-mail him at john.braun@ubc.ca.

Academic Integrity

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic

integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. **For example, incidences of plagiarism or cheating usually result in a failing grade or mark of zero on the assignment or in the course.** Careful records are kept to monitor and prevent recidivism.

A more detailed description of academic integrity, including the policies and procedures, may be found:

http://okanagan.students.ubc.ca/calendar/index.cfm?tree=3,54,111,0

If you have any questions about how academic integrity applies to this course, please consult with your professor.

Grading Practices

Faculties, departments, and schools reserve the right to scale grades in order to maintain equity among sections and conformity to University, faculty, department, or school norms. Students should therefore note that an unofficial grade given by an instructor might be changed by the faculty, department, or school. Grades are not official until they appear on a student's academic record. http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,41,90,1014 If you have any questions about how academic integrity applies to this course, please consult with your professor.

Disability Assistance

The Disability Resource Centre ensures educational equity for students with disabilities, injuries or illness. If you are disabled, have an injury or illness and require academic accommodations to meet the course objectives, visit our website for more information: http://students.ok.ubc.ca/drc/welcome.html or contact the DRC at: drc.questions@ubc.ca

Equity, Human Rights, Discrimination and Harassment

UBC Okanagan is a place where every student, staff and faculty member should be able to study and work in an environment that is free from human rights based discrimination and harassment. If you require assistance related to an issue of equity, discrimination or harassment, please contact the Equity Office, your administrative head of unit, and/or your unit's equity representative.

UBC Okanagan Equity Advisor: ph. 250-807-9291;

E-mail: equity.ubco@ubc.ca **Web:** https://equity.ok.ubc.ca/

Health & Wellness

At UBC Okanagan health services to students are provided by Health and Wellness. Nurses, physicians and counsellors provide health care and counselling related to physical health, emotional/mental health and sexual/reproductive health concerns. As well, health promotion, education and research activities are provided to the campus community. If you require assistance with your health, please contact Health and Wellness for more information or to book an appointment.

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Email: *healthwellness.okanagan@ubc.ca*

Web: www.students.ok.ubc.ca/health-wellness

Sexual Violence Prevention and Response Office (SVPRO)

A safe and confidential place for UBC students, staff and faculty who have experienced sexual violence regardless of when or where it took place. Just want to talk? We are here to listen and help you explore your options. We can help you find a safe place to stay, explain your reporting options (UBC or police), accompany you to the hospital, or support you with academic accommodations. You have the right to choose what happens next. We support your decision, whatever you decide. Visit svpro.ok.ubc.ca or call us at 250.807.9640

Independent Investigations Office (IIO)

If you or someone you know has experienced sexual assault or some other form of sexual misconduct by a UBC community member and you want the Independent Investigations Office (IIO) at UBC to investigate, please contact the ***IIO***. *Investigations are conducted in a trauma informed, confidential* and respectful manner in accordance with the principles of procedural fairness. You can report your *experience directly to the* ***IIO*** *via email: director.of.investigations@ubc.ca or by calling 604.827.2060* or online by visiting investigationsoffice.ubc.ca

The Hub

The Student Learning Hub (LIB 237) is your go-to resource for free math, science, writing, and language learning support. The Hub welcomes undergraduate students from all disciplines and year levels to access a range of supports that include **tutoring in math, sciences, languages, and writing, as well as help with study skills and learning strategies**. For more information, please visit the Hub's website (https://students.ok.ubc.ca/student-learning-hub/) or call 250-807-9185.

SAFEWALK

Don't want to walk alone at night? Not too sure how to get somewhere on campus?

Call Safewalk at 250-807-8076.

For more information: https://security.ok.ubc.ca/safewalk/ or download the UBC SAFE – Okanagan app.