STAT / ELEC 321 Stochastic Signals and Systems

Course Syllabus

Calendar description

- Stochastic behaviour of signals and systems (e.g., communication systems); discrete and continuous probability; random processes; modelling and identification of linear time-invariant systems; binary hypothesis testing and decision making.
- Prerequisite: One of ELEC 221, STAT 305 (STAT 305 may be taken concurrently).

Contact Information

- Part 1: Natalia Nolde (natalia@stat.ubc.ca); Part 2: Cyril Leung (cleung@ece.ubc.ca).

- Office hours: Wednesdays 2:15-3:00pm or by appointment.
- Online communication through Piazza online forum.

Course Structure

- There will be 4 weekly instructional meetings: three 50-minute lectures plus one 2-hour tutorial.

Course Content

- Part I:
    - **Chapter 1: Basic probability concepts** (axioms of probability, probability rules, conditional probability and Bayes' rule, the law of total probability, independence of events).
    - **Chapter 2: Random variables** (discrete and continuous random variables, probability mass function, probability density function, cumulative distribution function, expectation, variance; common discrete and continuous distributions (Bernoulli, Binomial, Poisson, uniform, exponential, Gaussian).
    - **Chapter 3: Random vectors** (joint distribution, conditional distribution, prior and posterior distributions, conditional expectation, conditional variance, expectation of functions of random variables, the law of total expectation, the law of total variance, independence between random variables, covariance, correlation coefficient, jointly Gaussian random variables, covariance matrix).
- Part II:
    - **Chapter 4 - Basic results from probability theory:** Bayes' rules, calculation of a posteriori probabilities, functional transformation of random variables, applications and examples.
    - **Chapter 5 - Bayesian inference**: General framework, estimation criteria, maximum likelihood (ML) estimation, maximum a posteriori (MAP) estimation, estimation of signals in Gaussian noise, least mean square (LMS) estimation, linear LMS estimation.
    - **Chapter 6 - Random processes**: Independent and identically distributed (i.i.d.) process, Bernoulli process, Poisson process, Gaussian process.

Course Learning Outcomes

- At the end of Part 1, students will be able to: apply basic axioms of probability to compute probabilities of random events, including conditional probabilities; use Bayes' Rule to indirectly calculate conditional probabilities; define and calculate probabilities of events involving random variables and vectors following standard distributions (binomial, Poisson, uniform, normal, exponential); assess and quantify linear correlation among random variables; derive the distribution of functions of random variables and vectors.
- At the end of Part 2, students will be able to: distinguish different optimality criteria in Bayesian inference; derive MAP estimator and the corresponding probability of error; derive LMS estimator and the corresponding error; derive linear LMS estimator and understand its relation to LMS estimator; recognize the basic properties of the Bernoulli, Poisson and Gaussian processes.

Course Activities and Assessment

- There are three lectures and one 2-hour tutorial every week.
- There will be two assignments for each part of the course (20% in total), a midterm exam (25%), a final exam (45%, students must pass the final exam to pass the course); tutorials – canvas quizzes (10%).
- Updates, course information, and other resources will be available on the course's website on UBC canvas.

References

- "A First Course in Probability" by S. Ross, 9th ed., 2012, Pearson (for Part I only)
- "Introduction to Probability" by D.P. Bertsekas and J.N. Tsitsiklis, 2nd ed., 2008, Athena Scientific.
- "Probability, Statistics, and Random Processes for Electrical Engineering" by A. Leon-Garcia, 3rd ed., 2008, Pearson.
- "Fundamentals of Communication Systems" by J.G. Proakis and M. Salehi, 2nd ed., 2014, Pearson.

Resources

- Lecture notes, tutorial notes and problem sets will be made available on the UBC canvas site for the course.

Course Policies

- Assignments are to be submitted online via file upload on canvas. Late assignments will incur a 1% per hour penalty.
- There will be no make-up exam. Students who have legitimate reasons for missing the midterm exam will have the weight transferred to the final exam. For the case of the final exam, students will need to apply for standing deferral through their faculty office and write the deferred final in the next offering of the course or during the official deferred exam period coordinated by Enrolment Services.

- Assignment and exam remark requests need to be made within one week of the return of the marked work, using the remark request form posted on the UBC canvas site for the course.

Academic Integrity

All students are expected to follow UBC's Academic Honesty and Standards policy (https://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,286,0,0#15620). We encourage students to discuss their work in solving the problems. However, you must write up your own solutions independently. This is not a group assignment, so we do not expect students to have similar writeup. Plagiarism is an academic offence and will be dealt with accordingly. Students must correctly cite references if you quote or use outside sources in your work. Breach of the academic integrity policy may, at a minimum, result in a grade of 0 on the relevant assessment or may result in more serious consequences.

Please see UBC's Academic Calendar for detailed policies on Academic Misconduct: http://calendar.ubc.ca/vancouver/index.cfm?tree=3,54,111,0

University Policies

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious, spiritual and cultural observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available here: https://senate.ubc.ca/policies-resources-support-student-success/.