STAT 305 – Introduction to Statistical Inference

Winter 2019/20, Term 2

Instructor: David Kepplinger

Contact Information

Instructor email: d.kepplinger@stat.ubc.ca

Course website: https://canvas.ubc.ca

Lectures: MWF, 4 – 5pm, Mathematics 100

Office hours: During the first week of classes on Monday 1–2pm, Wednesday 2–3pm and Friday 10–11am in ESB 3174. Regular office hours will be determined during the first lecture.

Teaching Assistants: Five Teaching Assistants will help you succeed in this course:

Daniel Hadley (daniel.hadley@stat.ubc.ca)

Alexi Rodríguez-Arelis (alexrod@stat.ubc.ca)

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All questions and discussions related to the *course content* should be posted on Piazza (link available on Canvas). Piazza is highly tailored to getting you help fast and efficiently from classmates, the Teaching Assistants, and your instructor. If you have questions of a more personal nature, such as questions about feedback on your quiz or to self-declare an absence, please email or speak to your lab Teaching Assistant or me directly.

Should you have concerns that you may not be able to fully participate or engage in any of the activities listed below, please do not hesitate to contact me either by email or speak to me in person during my office hours or after class. We can discuss alternative arrangements that suit your needs.

Course Description

Prerequisites: Either (a) one of STAT 200, STAT 203, BIOL 300, STAT 241, STAT 251, COMM 291, ECON 325, FRST 231, PSYC 218, PSYC 366, and one of MATH 302, STAT 302; or (b) a score of 65% or higher in one of MATH 302, STAT 302. The Department recommends that students meet the prerequisite through option (a). At the end of the first class you will be given a short self-assessment to determine whether you should brush up on some of the topics covered in prerequisite courses.

Topics covered: Probability theory (quick review), sampling distribution theory, large sample theory and methods of estimation and hypothesis testing, including maximum likelihood estimation, likelihood ratio testing and confidence interval construction. [3-0-1]

Learning Objectives: At the end of STAT 305, you will be able to

- identify applicable statistical approximations for large samples;
- derive and compute maximum likelihood estimators;
- apply Bayes' theorem to get posterior distributions of parameters and conduct Bayesian hypothesis testing;
- differentiate frequentist and Bayesian approaches to estimation and inference;
- formulate hypotheses appropriate for statistical inference;
- apply the Neyman-Pearson lemma to obtain sensible test statistics;
- interpret results of statistical inference;

Labs: Labs start in the second week of class. You will work in teams of 2–3 students on hands-on exercises related to topics covered in class. Group membership will be determined by the lab Teaching Assistant. For most labs, we will use the R data-analysis environment which is installed on the lab computers. At the end of each lab, a joint report for the team will be handed in. You will receive feedback for the report and the marks contribute to your grade.

Assignments: There will be approximately weekly online WeBWorK assignments for credit. Additional exercises will also be given approximately weekly but they will NOT be collected or marked. Brief answers will be provided in the course notes, and some of these exercises will be discussed in the lab or in class. No further solutions will be provided. If you have difficulties starting with a question or are stuck at some point in the solution, please see the teaching team during office hours. We are here to help YOU successfully complete the problem; it does not help you

if we do the problem for you. See us as often as you need to keep making progress. Working together in groups for these questions is allowed and very much encouraged. One purpose of all assignments is to prepare you for the quizzes and final, where similar questions will appear. The additional exercises are not part of assessment but are also an essential aid to succeed in this course.

Computing: Computing is an integral part of this course, e.g., to compute required probabilities. We will use the R data-analysis environment. The course website has information about how you may install R on your own computer. The website also provides examples and data sets as well as links to several online R tutorials, including a "getting started guide". Some of the assigned questions and most labs will involve computing. In labs, computers will be available for you to use. Familiarity with R will be tested on the quizzes and final examination.

Program of Work: The study time should total around eight hours per week. So in addition to the four contact hours, it is essential that learners spend no less than four hours per week on self-study for the course. It is suggested at least two hours per week are spent on revising and assimilating the material covered in the lectures or on guided reading, and at least two hours should be spent attempting the exercises and assignments that are set.

Textbook & Course Material

Required: The required course pack "STAT 305, Introduction to Statistical Inference" in the 2019 edition is available in the bookstore (*Stat 305 Ccm Kepplinger / 202; ISB: 281000032125*). Furthermore, an iClicker is required for this course and needs to be linked to your student account on Canvas.

References: Additional background information can be found in Chapters 2 – 6, 11, 13.2, 13.3 in "Mathematical Statistics with Applications in R"" by Ramachandran, K.M. & Tsokos, C.P (available online from the UBC library) and in "Mathematical Statistics and Data Analysis" (3rd edition) by Rice, J.A., on reserve at the Barber library.

Participation and Classroom Climate

Participation: Success in this course requires active participation while we walk through worksheets together in class and when you work on lab assignments in your teams. It is therefore expected that you attend classes and labs. During classes you will be asked to answer questions using your iClicker. Your lab team should sit together during classes, too, as the team will be called upon to answer questions from time to time. Participation in classes and labs contribute 15% to your grade.

Method of teaching: This class uses a flipped-classroom approach, where students engage with course material before class and participate in activities during class time. Classes of approximately fifty minutes of duration will occur three times a week, with worksheets being handed out at the beginning of the class. In all sessions, an in-class activity will replace at least part of the lecture component.

The current education literature suggests that the flipped classroom model can increase student performance in tests, quizzes, and homework, as well as improve students' understanding and retention of new material. More information about the flipped classroom model is available on UBC's flexible learning webpage.

What to bring: Some classes will feature online exercises and self-assessments which require the use of a laptop, tablet, or other device with internet connection. If possible, you should bring your device to class, but it is not mandatory. You are encouraged to work on these exercises in pairs so if you don't have a device during class, please pair up with someone who does. Moreover, a calculator will be necessary for some of the activities, so please bring one to class.

Classroom Climate: During classes and labs you are encouraged to discuss questions and answers in groups. To facilitate a respectful and inclusive classroom climate, be open to explore and challenge each other's ideas without criticizing individuals. Diversity is a source of creativity and innovation and I therefore ask that group members appreciate diverse perspectives and that they listen respectfully and let everyone speak. If you have concerns about the group dynamics or classroom climate, please do not hesitate to bring these concerns to the attention of your lab Teaching Assistant or myself.

Assessments and Grading

The grade is based on the following five components:

Component	Date	Percentage
Final exam	To be scheduled by Classroom Services	44%
Three quizzes	TBD in the first class	36% (12% each)
Lab activities	Weekly	10%
iClicker participation	In-class	5%
WeBWorK Homework	Almost weekly	5%

Requirements for passing: To pass the course it is necessary to score at least 50% overall AND at least 40% based on the quizzes and final exam alone (the quizzes and final exam combine for

80% of the overall grade). Only if both thresholds are satisfied, the grade reported is weighted based on all 5 assessment components.

Quiz: Quizzes are scheduled in class, with the dates decided on in the first class. They will start at the beginning of class, so please make sure you are on time. Quizzes will be based on material from assignments, WeBWorK, lab problems, and classes, including activities held in classes. If you would like a quiz question remarked, write a note specifying the question/part and the reason for requesting a review of grading. Attach this to your paper and give it to me or a Teaching Assistant no later than one week after the quizzes were returned to you. There will be no make-up quizzes.

In-class iClicker participation: During each class you can earn 5 points by using your iClicker device to answer between 5 to 7 questions. You get points for correct answers and for trying to get the correct answer. If you participate in more than 75% of the questions, you get 5 points. For each correct answer you get 4 points.

Examination aids: A one-sided, hand-written formula sheet without worked-out solutions can be used at the quizzes and final exam. More details will be provided on the course website. Please bring your student ID to the quizzes and final exam.

Academic integrity: The University of British Columbia values academic integrity. Read the UBC Policy on cheating, plagiarism, and other forms of academic dishonesty. The consequences of such behavior are serious.

Policy regarding missing the final exam: Students who miss the final exam must report to their Faculty advising office within 72 hours of the missed exam, and must supply supporting documentation. Only your Faculty Advising office can grant deferred standing in a course. You must also notify your instructor prior to (if possible) or immediately after the missed exam. Your instructor will let you know when you are expected to write your deferred exam. Deferred exams will ONLY be provided to students who have applied for and received deferred standing from their Faculty. Please note that if you are granted deferred standing for the STAT 305 final exam in term 2, you will be expected to write your deferred exam during the summer examination period in July. In such a case, make sure that you download the class notes from Canvas immediately, because you will not have access to them after April 29.

Policy regarding missing a quiz: Students missing a quiz for a valid reason will have the weights for the other quizzes and the final exam readjusted to total 80% (the quizzes and final make up 80% of the grading scheme). Valid reasons for missing a quiz are typically acute or changed medical

conditions, other emergencies, or an important UBC event. Students having a valid reason for missing a quiz must submit a self-declaration of absence (the form is available on Canvas) to me by email or hand it to me in person. Please note that even if a self-declaration of absence is submitted, only valid reasons will be accepted. As the quiz dates are known well in advance and are in class time, for example, normally there will be no accommodation for other classes, vacations, social events, business transactions, or similar activities. Please consult the UBC Policy on academic concessions and self-declarations.

Policy regarding missing classes or labs: In-class participation and lab assignments form an essential part of the assessment, but we understand that sometimes "life happens" and you may be unable to attend a class or a lab. Students having a valid reason for missing a class or a lab must submit a self-declaration of absence (the form is available on Canvas) by email or in person either to me (if missing a class), or to your lab Teaching Assistant (if missing a lab). If a student misses a class/lab and submits a self-declaration of absence, the weight for the other in-class iClicker participation, lab assignments, and WeBWorK homeworks will be readjusted to total 20% (the in-class participation, lab assignments, and WeBWorK homeworks make up 20% of the grading scheme). If a student misses a class/lab and does not submit a self-declaration of absence or the reason is deemed invalid, the missed lab/iClicker participation will be marked with 0 points. Please note that normally there will be no accommodation for other classes, vacations, social events, business transactions, or similar activities. Please consult the UBC Policy on academic concessions and self-declarations.

Tentative Course Schedule

The up-to-date course schedule can be found on the course webpage. Below is a tentative plan for the term. Please note that the days of the quizzes (Monday, Wednesday, or Friday) will be determined in the first lecture.

Week	Topics covered	Course notes
1	Introduction and self-assessment of prerequisites, moments and moment generating functions (MGFs)	1.8
2	Approximation via MGF, properties of the Normal distribution	2.1 – 2.4
3	Approximate Normal distribution, estimators and their properties	2.5 – 3.3
4	Maximum likelihood estimation with a single parameter	4
5	**Quiz #1**, maximum likelihood estimation with several parameters	5
6	Bayes' rule ~~Midterm break~~	6.1 – 6.3
7	Posterior and prior distributions, Introduction to hypothesis testing	6.4 – 7.2

Week	Topics covered	Course notes
8	**Quiz #2**, cont. hypothesis testing	7.3
9	Neyman-Pearson lemma, composite hypotheses, Generalized likelihood-ratio tests	7.4 – 7.5
10	p-values, connection with confidence intervals, inference for categorical data	7.6 – 8.3
11	**Quiz #3**, goodness of fit tests	8.4
12	Comparing 2 independent samples, comparing multinomial distributions, paired comparisons	9.1 – 9.5
13	Capstone project and wrap-up	