STAT 306 - *Finding Relationships in Data*

Winter Term 2 (January 9 – April 13, 2023)

Course description: Modeling a response (output) variable as a function of several explanatory (input) variables: multiple regression for a continuous response, logistic regression for a binary response, and log-linear models for count data. Finding low-dimensional structure using principal components analysis.

This course emphasizes (i) applications of statistical methods such as multiple regression, binary regression, principal component analysis; (ii) the use of statistical software to do the computations; and (iii) interpretation of statistical analysis and output of statistical software. There is some linear algebra (with matrix representations) to show how multiple regression is computed in software, and there is some probability (mainly expected values, variances and covariances for linear combinations) to show how standard errors are determined for parameter estimates and predictions.

Objectives: On completing the course, students should be able to demonstrate an understanding of the techniques and applications of well-known ideas in linear modelling, including model fitting, model selection, model diagnostics, as well as basic ideas for generalised linear models and principal components analysis.

Learning outcomes: Detailed learning outcomes are provided on the course website

Pre-requisites: One of MATH 152, MATH 221, MATH 223 and one of STAT 200, STAT 241, STAT 251, STAT 300, BIOL 300, COMM 291, ECON 325, ECON 327, FRST 231, PSYC 218, PSYC 278, PSYC 366 and one of MATH 302, STAT 302.

Teaching style: This course is delivered with a flipped-classroom approach, where little time is devoted to seminar-style lectures. Instead, students learn by directly engaging with the material, for example through in-class group activities. See below for more detail.

Instructor: Ben Burr (Email: ben.burr@stat.ubc.ca). Please use the email only for personal matters that need to be discussed directly with the instructor. Please use **office hours** or Piazza for questions regarding assignment problems, textbook problems, labs, class notes, examples, etc.

Classroom: LSK 200 (Tuesday and Thursday | **Class Time**: 3:30pm-5:00pm)

Instructor Office Hours: Mondays, 2-3pm in ESB 1043. Details available on Canvas.

Teaching assistants

Xinglong Li (xinglong.li@stat.ubc.ca) [Head TA]
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TA office hours: To be announced. Details will be available on Canvas.

Course Website: **canvas.ubc.ca**
Please check the **Canvas** website regularly to keep up-to-date with the course. Everything you need will be available through Canvas and you should get familiar with all the tabs as soon as possible. If you have any problems related to technical issues, please use **?Help** (see the left side menu in the Canvas course page) to report the problem or to contact IT service.

Recommended texts:
There are a variety of books that cover at most of the material in this course, and it is suggested you try the UBC online library stock to find those that suit you. The course notes are:

Joe, Harry. (2020) Course Notes for STAT 306: *Finding Relationships in Data* which can be ordered from the UBC bookstore.

Amongst other useful texts, both available via the library website, are
Chatterjee, S. and Hadi, A.S. (2006): *Regression Analysis by Example* (4th ed.). Wiley (In particular chapters 1-6, 11, 9.1-9.7, 12.1-12.7,13.3 are covered.)
Weisberg, S. (2014): *Applied Linear Regression*, (3rd ed.). Wiley.

Teaching methods: 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 1.5 hours will occur twice a week, with two online pencasts describing related materials for each week being available in advance. A pre-class activity and quiz (ungraded) is set before each class that should be completed on the morning of class days. In all sessions an in-class activity will replace at least part of the lecture component. R will be necessary for many of the in-class activities. Guided reading or other activities will be set at the end of some lectures to be completed prior to the next. There will be required lab assignments most weeks. 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. To learn more about the flipped classroom model, go to: http://flexible.learning.ubc.ca/research-evidence/research-articles-2/flipped-classroom

Programme of work: The study time should total around 8-10 hours per week. In addition to the contact hours, it is essential that learners spend approximately 5 hours per week on self-study for the course. A proposed workload for a typical week is as follows:

- Classes: 3 hours
- Lab: 1 hour
- Preparatory Activities (pre-class quizzes, pencasts, other reading): 2 hours
- WeBWorK: 2 hours
- Reading/reviewing: 1-2 hours
- Additional assignments and projects: 1-2 hours

Assessment	**Percentage**
In-class activities (iClicker Cloud)	10%
WeBWorK	10%
Labs	10%
Written Assignments (2)	10%
Group Project	10%
Midterm	20%
Final Exam	30%

Bonus Points: If you do not use any Flexibility Time (see below), you will be granted 2% bonus on your final grade (to a maximum of 100%).

Week	**Class Dates**	**Assessments**	**WeBWorK**	**Labs**
1	Jan 10/12	No labs. In-class activities/clicker questions starting from the first class.	None	
2	Jan 17/19	Labs begin. Last date to withdraw with no W shown on transcript is January 20, 2023.	WW 1	Lab 1
3	Jan 24/26		WW 2	Lab 2
4	Jan 31/Feb 2	**Assignment 1 due** February 3	WW 3	Lab 3
5	Feb 7/9		WW 4	Lab 4
6	Feb 14/16		WW 5	Lab 5
7	Feb 21/23	Reading Break		
8	Feb 28/Mar 2	Last date to withdraw with W shown on transcript is March 3, 2023. **Midterm Test**, March 2, 2023	WW 6	
9	Mar 7/9		WW 7	Lab 6

10	Mar 14/16	**Group Project Proposal submission due** March 17	WW 8	
11	Mar 21/23		WW 9	Lab 7
12	Mar 28/30	**Assignment 2 due** March 28	WW 10	Lab 8
13	Apr 4/6		WW 11	
14	Apr 11/13	**Group Project due** April 13	WW 12	
	Apr 17-28	**Exam Period**		

Policy regarding missing the midterm test:

1. There will be no make-up test.
2. Students who miss the test should notify the instructor prior to (if possible) or immediately after the exam. Students must supply a supporting document (for example, a doctor's note will be sufficient in case of a medical emergency) within one week of the day of exam.
3. Students who miss the test for a reason not covered in UBC's Academic Calendar will be given a grade of 0 on the test.

Deferred Exam Policy if you miss the Final Exam: The policy (UBC policy) is that students who miss the final exam MUST report to their faculty advising office within 48 hours to apply for deferred standing. They must also notify the instructor to receive instructions as to when they will write their deferred final. It will most likely be in the final exam period in the next term in which the course is offered. E.g., for 2022W2, the next offering of STAT 302 will be 2023S2, so the deferred exam will take place in mid-August. But they will not be granted a deferred final unless they are granted deferred standing by their faculty advising office.

Policy regarding exam grade: You must pass the final exam to pass the course.

Policy regarding grading flexibility: This policy is strictly to account for the possibility that you may experience illness or life circumstances that prevent you from handing in your work. We will automatically drop your lowest 3 iClicker scores at the end of the term. We will automatically drop your lowest lab score at the end of the term. We will automatically drop your lowest WeBWorK score at the end of the term. Lowest grades will automatically be removed after classes have finished. You do not need to contact the teaching team about this. An opportunity will be given following the final exam and final grade calculation to check that your lowest score has been dropped.

Policy regarding extension requests on written assignments and WeBWorK: No extensions will be granted on any written assignment or WeBWorK assignment. Late submissions will fall under the Flexibility Time policy below.

Flexibility Time: Each student will have 48 hours in total of Flexibility Time for the semester. If a written assignment or WeBWorK assignment is submitted late, Flexibility Time will be automatically used to account for this. If one of these assignments is submitted **at any time within the first hour**, it is counted as 1 hour late. If it is submitted at any time within the second

hour, it is counted as 2 hours late. And so on. There is no need to contact the teaching team about this. Late hours will be calculated at the end of the semester when tabulating final grades. Bonus points will be rewarded for not using any Flexibility Time. Flexibility Time cannot be used for labs. Any missed labs will result in a grade of 0.

Late submissions of assignments and WeBWorK: Any late submission beyond your 48 hours of Flexibility Time receives a grade of 0.

iClicker cloud: We will be using iClicker Cloud in lectures. iClicker Cloud is a response system that allows you to use your own computer or mobile device to respond to questions posed by instructors during class. You need to set up an iClicker Cloud account and add STAT 306 as a course to this account. To do so, please follow https://lthub.ubc.ca/guides/iclicker-cloud-student-guide for details. Please ensure that your iClicker Cloud student ID identifies you by your name as it appears in Canvas.

Piazza Discussion Board: You can use "Piazza Discussion Board" to post your questions. This is where you can discuss ideas, strategies, and resources for solving the problems with your classmates. Please DO NOT POST ANSWERS to the questions in the WeBWorK assignments/written assignments and Labs. Instead, share your thoughts and approaches to solving the problems. Asking others how to solve a problem without first trying to solve it yourself will not be beneficial for your learning. TAs will not give the solution for assignment questions before the due date. But they will surely give hints as needed and let you know the correct directions. If you need more clarification, it is always better to contact TAs or the instructor during our office hours. Don't expect TAs will answer all your questions posted in Piazza page. If you have any problems or feedback for the developers of Piazza, email team@piazza.com. To access the course Piazza page, please go to **"Piazza"** in the left menu in the Canvas course page and it will open in a new window. Then you can sign up for the class page. Please use the email address associated with your Canvas account.

WeBWorK: Please see the WeBWorK assignment dates in the Canvas course page. Please go to **"WeBWorK"** in the left menu in the Canvas course page to access WeBWorK.

Labs: Groups will be assigned for the labs and other group activities by the beginning of the second week of class. Lab assignments start the second week of class. Lab materials will be provided in the lab sessions. You are expected to work with your group in the lab to solve the lab assignments and hand in the finished lab activity at the end of the lab.

Group Project: There will be a group project in which students will work in pre-assigned groups on a data set of their selection. Groups will be assigned for the beginning of the second week of class. Further details will be available on Canvas. The final project is a written report submitted during the last week of term. You will be graded on writing. There is an interim stage proposal for review that is due at the beginning of Week 9.

Rough Lecture Topic Outline: There follows a provisional guide to the lectures. It is possible that the material covered in the classes will differ slightly from the description below. For each lecture, there is a corresponding pre-class activity, an in-class activity, and there will be associated questions in the labs and the WeBWorK.

1. Introduction and Motivation. Exploring Relationships Between Two Variables.
2. Least Squares Estimation for the Simple Linear Model.
3. Residuals. Properties of the Model.
4. Confidence Intervals for the Slope and an Expected Response.
5. Prediction Intervals.
6. Distribution Theory; Why the T Distribution?
7. Matrix Formulation of Linear Models.
8. Properties of Least Squares Estimators in Matrix Form.
9. Properties of Residuals and the Residual SS.
10. Dummy Variables in Linear Models.
11. More on Categorical Variables in Linear Models.
12. Quadratic Models and Curve Fitting.
13. Examining Case Studies.
14. Review Activity.
15. Mid-Term Test.
16. Model Selection, Including Mallows' Cp Statistic.
17. Leverage, Influence, Outliers, and the “Hat” Matrix.
18. Transformations.
19. A Case Study.
20. Introducing Logistic Regression.
21. Further Logistic Regression.
22. Model Selection in Logistic Regression.
23. Introducing Poisson Regression and Principal Components Regression.
24. Further Poisson Regression and Principal Components Analysis.
25. Review Session.

Covid Safety in the Classroom

Lectures: In-person
Labs: In-person
Office hours: Please see more information in the Canvas page. In-person by appointment.

Masks: Masks are no longer required for all indoor public spaces on campus, as per the BC Public Health Officer orders and UBC policy. Despite this change in policy, Covid-19 continues to spread rapidly in the community, new variants arise, and many thousands of people continue to experience acute and long-term health problems causing long-term health damage and hundreds of deaths per week in Canada alone. For our in-person meetings in this class, it is important that all of us feel as comfortable as possible engaging in class activities while sharing an indoor space. Masks are a primary tool to make it harder for Covid-19 to find a new host. You are encouraged to wear a medical or non-medical mask for the duration of our class meetings for your own protection and the protection of everyone else in the class and their close contacts. You may be asked to remove your mask briefly for an ID check for an exam but not otherwise. Mask wearing protects you as well as others in your environment. Let's do everything we can as a community to stop the spread of this virus.

Vaccination: If you have not yet had a chance to get vaccinated against Covid-19, vaccines are available to you, free, and on campus (http://www.vch.ca/covid-19/covid-19-vaccine) The higher the rate of vaccination in our community overall, the lower the chance of spreading this virus. You are an important part of the UBC community. Please arrange to get vaccinated if you have not already done so.

Seating in class: To reduce the risk of Covid transmission, **please sit in a consistent area** of the classroom each day. This will minimize your contacts and will still allow for the pedagogical methods planned for this class to help your learning.

Your personal health

If you're sick, it's important that you stay home – no matter what you think you may be sick with (e.g., cold, flu, other).

- Do not come to class if you have Covid symptoms, have recently tested positive for Covid, or are required to quarantine. You can check this website to find out if you should self-isolate or self-monitor: http://www.bccdc.ca/health-info/diseases-conditions/covid-19/self-isolation#Who.
- Your precautions will help reduce risk and keep everyone safer. In this class, the marking scheme is intended to provide flexibility so that you can prioritize your health and still be able to succeed.

If you do miss class because of illness:

- Make a connection early in the term to another student or a group of students in the class. You can help each other by sharing notes. If you don't yet know anyone in the class, post on the discussion forum (Piazza) to connect with other students.
- Consult the class resources on Canvas.
- Use the online discussion forum (Piazza) for help.
- Come to online office hours (instructor and TAs) to contact us and discuss.

If you are sick on a midterm exam day, please email the instructor as soon as you are confident you should not come to the scheduled exam. It is much better for you to email ahead of time and not attend. Remember to include your full name and student number in your message.

If you are sick on a final exam day, do not attend the exam. You must follow up with your home faculty's advising office to apply for deferred standing: https://students.ubc.ca/enrolment/academic-learning-resources/academic-advising. Students who are granted deferred standing write the final exam/assignment at a later date.

If you're a Science student, you must apply for deferred standing (an academic concession) through Science Advising no later than 48 hours after the missed final exam/assignment. Learn more and find the application online: https://science.ubc.ca/students/advising/concession.

For additional information about academic concessions, see the UBC policy here:

http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,329,0,0

http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,329,0,0

Instructor health

If I (the instructor) am sick: I will do my best to stay well, but if I am ill, develop Covid symptoms, or test positive for Covid, then I will not come to class. If that happens, here's what you can expect

- If I am well enough to teach, but am taking precautions to avoid infecting others, we may try to hold a synchronous online session. If this happens, you will receive an announcement in Canvas telling you how to join the class. You can anticipate that this would very likely be a last-minute email. Our classroom will still be available for you to sit and attend an online session, in this (hopefully rare) instance.
- You may receive a message from me with a recording of the lecture material for you to watch on your own time.
- My colleague might substitute for me for in-person classes

Academic Integrity: Class Policies on Exams and Assignments

Exams: Exams are in-person.
Assignments/WeBWorK/Labs:

- Discussion of ideas learned in class is encouraged (with other students, TAs or the instructor). This helps the learning process. But individual work turned in by each student should be your own work. Do not copy or paraphrase solutions from other students or from other sources. Do not provide your solutions to another student. Failure to comply with these rules will result in an automatic 0 for your work, and additional academic penalties.

For more information, please see

Academic Honesty and Standards:

http://www.calendar.ubc.ca/Vancouver/index.cfm?tree=3,54,111,958

Academic Misconduct: http://www.calendar.ubc.ca/Vancouver/index.cfm?tree=3,54,111,959

Disciplinary easures:http://www.calendar.ubc.ca/Vancouver/index.cfm?tree=3,54,111,960

Note:

- Please check the Canvas course page regularly.
- No late submission (WebWorK/ Labs/Exams/Assignments/Canvas Quizzes) will be accepted.
- You are allowed to discuss lab assignments/WebWorK/ Written Assignment questions with other students via Piazza discussion board. But DO NOT post answers in the Piazza page.
- Grades change request forms (for midterm and assignments) should be submitted within one week after grade released/post solution on canvas page. Re-marking requests should **only** be raised when you are **sure** that the markers have made a mistake in marking your paper when you compare your paper with the marking scheme. Re-marking is not meant to give students a way to ask for more marks or to dispute the grading decisions of the markers. A re-grade may result in a higher or lower mark for the student.
- I will typically not be able to answer your questions about assignment problems/textbook problems/class note examples etc. by email. Please use **office hours** and **Piazza Discussions** for those kinds of questions**.** Please use the instructor email only for personal matters (e.g. if you are going to miss the midterm exam/lab due to some unavoidable circumstance covered by UBC's Academic Policies or some other important matter related to the course). We are always there to help you during our office hours.

Reach Out for Success

- University students often encounter setbacks from time to time that can impact academic performance. Discuss your situation with your instructor or an academic advisor. Learn about how you can plan for success at: www.students.ubc.ca
- For help addressing mental or physical health concerns, including seeing a UBC counsellor or doctor, visit: https://students.ubc.ca/health-wellness