

Course Outline
Biostatistics for Integrative Biology
STAT *2230
University of Guelph, Winter 2017

October 18, 2016 version

I. General Information

Calendar description: This course introduces students to the design, completion and interpretation of research projects, including identifying categories of research questions, types of data, data gathering methods, efficient graphic and numeric methods to summarize data, standard statistical analyses involving parameter estimation and hypothesis tests and interpreting results in the context of research goals. Statistical concepts underlying practical aspects of biological research will be emphasized. Computer-intensive laboratory sessions will focus on practical data organization, visualization, statistical analysis using software, and interpretation and communication of statistical results. Department of Mathematics and Statistics and Department of Integrative Biology.

Prerequisite(s): BIOL*1070

Restriction(s): BIOL*2250, STAT*2040, STAT*2060, STAT*2080, STAT*2120, STAT*2250. Enrollment restricted to the BSC majors in BIOD, ECOL, MFB, WBC, WLB, ZOO and BSES majors in in ECOL and ECOL:C.

Instructor: Prof. Andrew McAdam, Department of Integrative Biology
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Office hours: TBD

Instructor: Prof. Andrew Skelton, Department of Mathematics & Statistics
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TAs: TBD

Lecture: 10:30-11:20 MWF, ALEX 100

Labs: Monday 2:30-4:20, SSC 1306 (*0101)
Wednesday 1:30-3:20, SSC 1306 (*0102)
Thursday 11:30-1:20, SSC 1306 (*0103)
Friday 3:30-5:20, SSC 1306 (*0104)

NOTE: For the first 3 weeks of the semester labs will be in SSC 1305

Midterm exam: TBD

Final exam: TBD

II. Learning outcomes

This course is designed to give students experience and confidence in the design and analysis of data within realistic biological research contexts. Students will gain basic practical experience in displaying, summarizing, analyzing and interpreting biological data in applied research contexts using standard statistical methods.

At the end of this course students should:

1. Understand the statistical concepts of bias, variability, and sampling distributions.
2. Select the appropriate statistical method for a given data set.
3. Evaluate the quality of data collected from observational and experimental studies.
4. Make and interpret visual summaries of data.
5. Use statistical computer software to explore and analyze data.
6. Understand statistical language as used in the primary biological literature.
7. Interpret statistical results and communicate them to other biologists.

III. Course content

Our TENTATIVE schedule of lectures and labs is as follows. Chapter numbers currently refer to Samuels et al. 2016, 5th edition.

Monday	Wednesday	Thursday	Friday
January 9 (AMc/AS) Why do you need statistics? Sources of variability No Lab	Jan 11 [AMc] Type of evidence Sampling (Chapter 1) No Lab	 No lab	January 13 (AMc) Type of evidence Sampling (Chapter 1) No Lab
January 16 (AMc) Description of samples (Chapter 2) Lab 1: Introduction to R	Jan 18(AMc) Description of samples (Chapter 2) Lab 1: Introduction to R	 Lab 1: Introduction to R	January 20 (AMc) Description of samples (Chapter 2) Lab 1: Introduction to R
Jan 23 (AS) Normal distribution (Chapter 4) Lab 2: Sampling, Description of samples	Jan 25 (AS) Normal distribution (Chapter 4) Lab 2: Sampling, Description of samples	 Lab 2: Sampling, Description of samples	January 27 (AS) Normal distribution (Chapter 4) Lab 2: Sampling, Description of samples
Jan 30 (AS) Confidence intervals (Chapter 6) Lab 3: Normal distribution	Feb 1 [AS] Confidence intervals (Chapter 6) Lab 3: Normal distribution	 Lab 3: Normal distribution	Feb 3 (AS) Bias and precision One-sample hypothesis tests (Chapter 6) Lab 3: Normal distribution
February 6 (AMc) Experimental design I Comparison of two	Feb 8 [AMc] Experimental design I Comparison of two	 	February 10 (AMc) Comparison of paired samples (Chapter 8)

independent samples (Chapter 7) Lab 4: Confidence intervals	independent samples (Chapter 7) Lab 4: Confidence intervals		
Feb 13 [AMc] Review	Feb 15 Review	No lab	Feb 17 Midterm
Feb 20 BREAK	Feb 22 BREAK	Feb 23 BREAK	Feb 24 BREAK
February 27 (AS) Chi-square goodness of fit (Chapter 9) Lab 5: Experimental design Comparison of independent samples	Mar 1 [AS] Chi-square goodness of fit (Chapter 9) Lab 5: Experimental design Comparison of independent samples		Mar 3 [AS] Contingency tables (Chapter 10) Lab 5: Experimental design Comparison of independent samples
March 6 (AMc) Experimental design II Lab 6: Experimental design Comparison of paired samples	Mar 8 [AMc] Experimental design II, One-way ANOVA, Lab 6: Experimental design Comparison of paired samples		March 10 40th class day (AMc) One-way ANOVA (Chapter 11) Lab 6: Experimental design Comparison of paired samples
March 13 (AS) Multiple comparisons (Chapter 11) Lab 7: Chi-square goodness of fit Contingency tables	Mar 15 ANOVA w/blocks [AS] (Chapter 11) Lab 7: Chi-square goodness of fit Contingency tables		March 17 (AS) ANOVA w/blocks (Chapter 11) Lab 7: Chi-square goodness of fit Contingency tables
March 20 (AMc) Two-way ANOVA (Chapter 11) Lab 8: One-way ANOVA Multiple comparisons	Mar 22 [AMc] Two-way ANOVA (Chapter 11) Lab 8: One-way ANOVA Multiple comparisons		March 24 Linear regression and correlation (Chapter 12) Lab 8: One-way ANOVA Multiple comparisons
March 27 (AS) Linear regression and correlation (Chapter 12) Lab 9: ANOVA w/blocks Two-way ANOVA	Mar 29 [AS] Linear regression and correlation (Chapter 12) Lab 9: ANOVA w/blocks Two-way ANOVA		Mar 31 (AMc /AS) Case studies Lab 9: ANOVA w/blocks Two-way ANOVA
Apr 3 (AMc /AS) Case studies No lab	Apr 5 [AMc] Case studies No lab		April 7 LAST DAY of classes (AMc /AS) Review No lab

General information on lectures

-For your convenience, drafts of slides will be posted on Courselink prior to lecture. However, please note that these drafts can differ from the final, corrected versions of the slides, which will be posted on Courselink after lecture.

-We will ask you to confer with your neighbours during lecture to discuss TopHat questions. We do this because research shows that students who work with their neighbours to answer questions in class score better on exams than students who do not interact with their peers.

General information on labs

-Labs will be run by TAs who will introduce the lab assignment, lead discussion, and give pointers on using R. While we do not take attendance at labs, we strongly encourage you to attend.

-Be sure to save the work you do in the lab (data files, output, word processing) and mail it to yourself before you leave. Alternatively, you can save your work on a memory key.

Important Dates in 2016

Jan. 9	First day of classes
Jan. 16-20	First lab
Feb. 20	Reading week
Feb. 17	Midterm (in class)
Mar. 10	Course drop deadline (40th day classes)
Apr. 7	Last day of classes
TBD	Final Exam. Location: TBA

IV. Course Resources

Required resources

Top Hat: To facilitate discussion and to enhance your learning in and out of class, we will be using educational software called *Top Hat*. *Top Hat* allows you to answer questions and engage in discussion using your smartphone, tablet or laptop. You will need to purchase the *Top Hat* app. instructions for purchasing, downloading and setting up the *Top Hat* software will be provided by e-mail/*Courselink*

R statistical software: We will be using the software package R to analyze data in labs. R is freely available. If you wish to download a copy for your personal computer, you can do so at the following website: <http://cran.r-project.org>.

Note that R is not menu-driven. You will need to type in code to manipulate and analyze data. However, you can turn R into a menu-driven program by installing R commander from the following website: <http://socserv.mcmaster.ca/jfox/Misc/Rcmdr/>.

Guide to using R: Dalgaard, P. 2008. Introductory Statistics with R, Second Edition. New York, Springer.

PDFs of Dalgaard (2008) are available for free download through the University of Guelph library.

Recommended Resources

Textbooks:

Samuels, M.L., J. A. Witmer, and A. A. Schaffner. 2016. Statistics for the Life Sciences, Fifth Edition. New York, Pearson.

Whitlock, M. C., and D. Schluter. 2015. The Analysis of Biological Data, Second Edition. MacMillan Learning.

You will also be able to use these books as well as your own notes during the open-book midterm and final exam.

V. Methods of Assessment

Assessment		Due Date
Lab assignments	25%	Weekly (Learning outcomes #1-7)
Midterm Exam	30%	February 17th (Learning outcomes #1, 3, 4, and 7)
<i>Top Hat</i> Questions	5%	All semester beginning Monday January 23rd (Learning outcomes #1-4, 7)
Final Exam	40%	TBD (Learning outcomes #1-5, 7)

Top Hat questions: 5% of your final grade will be based on your graded responses as well as on your participation in *Top Hat* questions in class. We will practice using *Top Hat* in lecture on January 11 - 20. We will begin graded *Top Hat* questions on January 23. Your lowest 3 grades for *Top Hat* questions will be deleted from your grade calculation so that you will not be penalized for illness or other occasional absences from class.

Lab assignments: The assignments are designed to give you experience in data management, experimental design, graphical methods, and statistical analysis using R, as well as reinforce concepts presented in lectures. The assignments and any required data sets will be posted on Courouselink. The first lab will not be graded. There will, therefore, be 8 graded assignments in total, but your lowest assignment grade will be dropped. **Late assignments will not be accepted!!!!**

Because of limited computers, students will work together in pairs. Discussion often leads to better understanding and so we encourage group thinking. However, we urge you to not divide up the work. You will get the best value if you work together to increase your comprehension and not to do less work. Statistical analysis, data exploration, and the learning of statistical software only comes with experience. Each student must hand in a

separate complete assignment, and no part of this should be copied from another student. Academic dishonesty, such as plagiarism (including copying all or part of an assignment) and impersonation is grounds for loss of course credit and dismissal. More information on the subject of academic misconduct can be found at the following website:
http://www.uoguelph.ca/undergrad_calendar/c08/c08-amisconduct.shtml

You will be submitting completed assignments online using a grading software called **Crowdmark**. You will receive online submission instructions via your University of Guelph e-mail address for each assignment. It is your responsibility to check for this e-mail and to contact Dr. Skelton if you do not receive the e-mail for a particular assignment. More details regarding this process will be provided on each assignment. Marked assignments will be returned via e-mail. We will do our best to return the assignments one-week after the due date.

You are responsible for answering all of the questions on each assignment because these will help prepare you for the course exams. **However, only approximately half of each assignment will be graded each week.** You will not know in advance which questions will be subject to grading. Solutions for each assignment will be posted on the course website on Tuesday evening. It is up to you to check the answer sheet to evaluate your performance on the unmarked questions.

Exams: There will be one midterm and one final exam in the course. Tests will generally address the following topics: numerical and mechanical skills, your ability to critically evaluate the quality of data (e.g., data collection, experimental method) or of the experimental design and analyses, and the legitimate interpretation of results in a biological context. Students are allowed to use their notes, copies of assignments, a calculator, and the course textbook during the midterm and final. Do not bring laptop computers, cell phones, or smartphones.

VI. Course Policies

Academic Accommodation of Religious Obligations

If you are unable to complete a course requirement due to religious obligations, please let the instructor know within the first two weeks of class. See the academic calendar for more information:

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml>

When You Cannot Meet a Course Requirement: When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons, please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact, and be prepared to provide supporting documentation. See the undergraduate calendar for information on regulations and procedures for Academic

Consideration:

Consideration may be granted at the instructors discretion. Please note that consideration for medical, compassionate or university-related conflicts (e.g., varsity sports) may require additional discussion with your program counsellor. Consideration is generally more likely when the student proactively advises the instructor of issues well in advance of deadlines.
<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Academic misconduct: The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:
<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

Calendars: The calendar is the source of information about the University of Guelph's procedures, policies and regulations that apply to undergraduate, graduate and diploma programs:
<http://www.uoguelph.ca/registrar/calendars/index.cfm?index>

Copies of out-of-class assignments: Keep paper and/or other reliable back-up copies of all out-of-class assignments; you may be asked to resubmit work at any time.

Course evaluations: Because this course is co-taught by the departments of Math-Stats and Integrative Biology, we encourage you to provide evaluations of the course and instructors separately to each department.

The Integrative Biology evaluation can be performed on-line through the CCS course evaluation website:
https://courseeval.uoguelph.ca/CEVAL_LOGIN.php

The Math-Stats evaluation can be performed on-line through the CCS course evaluation website:
https://courseeval.uoguelph.ca/CEVAL_LOGIN.php

DEPARTMENT OF MATHEMATICS AND STATISTICS TEACHING EVALUATION PROCESS

- Each course taught by the Mathematics and Statistics Department is evaluated in the last two weeks of the semester. Note that the completed evaluation and any comments will not be passed on to the instructor, the Chair, and the Departmental Tenure and Promotion Committee until after all the final grades have been submitted following the final examination period.
- Your input provides important feedback to the instructor and becomes an important part of the Departmental Tenure and Promotion Committee's teaching evaluation of the instructor.
- Numerical results calculated from the 7 questions are provided to the instructor and are used by the Departmental Tenure and Promotion Committee in making faculty salary and promotion decisions.
- Comments from unsigned evaluation forms are passed only to the instructor after the final grades have been submitted following the final examination period.
- If you wish your comments to also go to the Chair and the Departmental Tenure and Promotion Committee, you must include your clearly legible handwritten signature, with your legibly printed name and student number in the provided spaces. Note that comments that do not include a clearly legible handwritten signature are not allowed to be passed on to the Chair and the Departmental Tenure and Promotion Committee.
- These comments are made available to the Promotion and Tenure Committee only after the faculty member has had the opportunity to read and respond to the contents. Your identity will be made available to the Chair, the Department committee and the faculty member after final grades have been submitted.

Drop date: The last date to drop one-semester courses, without academic penalty, is the 40th class day: March 10, 2017. To confirm the actual date please see the schedule of dates in the Undergraduate Calendar. For regulations and procedures for dropping courses, see the Undergraduate Calendar:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

E-mail communication: As per university regulations, all students are required to check their <mail.uoguelph.ca> e-mail account regularly; e-mail is the official route of communication between the University and its students.

Recording of materials: Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

Student responsibilities : You should plan on spending a minimum of ten hours per week working on this course, in addition to time spent in lectures and tutorials. This time includes reading the required sections of the textbook, reviewing and/or rewriting lecture

notes, preparing questions on any material with which you need help, doing practice problems, and working on your lab assignments. The Instructors and TAs will offer as much assistance as possible. However, remember that this is your learning experience, and you will get as much out of this class as you put into it.

VII. Campus Resources

If you are concerned about any aspect of your academic program:

-make an appointment with a program counsellor in your degree program.

<http://www.bsc.uoguelph.ca/index.shtml> or
<https://www.uoguelph.ca/uaic/programcounsellors>

If you are struggling to succeed academically:

-There are numerous academic resources offered by the Learning Commons including Supported Learning Groups for a variety of courses, and workshops related to time management, taking multiple choice exams, and general study skills. You can also set up individualized appointments with a learning specialist.

<http://www.learningcommons.uoguelph.ca/>

If you are struggling with personal or health issues:

-Counselling services offers individualized appointments to help students work through personal struggles that may be impacting their academic performance.

<https://www.uoguelph.ca/counselling/>

-Student Health Services is located on campus and is available to provide medical attention. <https://www.uoguelph.ca/studenthealthservices/clinic>

-In addition to Health Services and Counselling Services, Kathy Somers runs training workshops and one-on-one sessions related to stress management and high performance situations. <http://www.uoguelph.ca/~ksomers/>

Accessibility

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability or a short-term disability should contact the Student Accessibilities Services (SAS) as soon as possible. For more information, contact SAS at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: <http://www.uoguelph.ca/csd/>