MDSC 403
Computation for Bioinformatics

Instructor:

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Office Hours/Policy on Answering Student Emails

Office Hours Friday 12 noon – 1 pm (Students must arrange a minimum of 3 days in advance to meet).
Student emails will be answered within 3 business days. Please note that most questions should be posed at the beginning or end of class.

Time and Location:

Thursdays, 3 – 5:45 pm
HS 1501 (Bioinformatics Computer lab)
Please consult course schedule to confirm location of individual sessions.

Prerequisite/Co-Requisite:

Permission of Instructor

Course Description:

This advanced course will focus on current computational methods in bioinformatics. Topics will shift as computational methods in bioinformatics shift. Currently, the course will focus on in-depth usage of R and Bioconductor, including reproducible research. Lecture topics will include an introduction to fundamental and idiomatic R constructs and usage and creation of Bioconductor packages.

Overarching Theme

Computation is central to bioinformatics. For many years, the R framework and the Bioconductor series of packages have been seen as essential parts of the toolkit of bioinformaticians. Recent years have seen great improvements in R as an environment for data science and bioinformatics. Students in this course will develop facility in R programming, including several advanced topics, with a focus on the most widely-used and useful approaches and packages. Students will leave this course with the ability to manipulate and analyze data in R and a basic knowledge of widely-used packages in Bioconductor for bioinformatics data analysis. This course will use a blended format with a combination of students using online and

video lectures at home with in-class lecture content to expand upon a subset of topics. Students will primarily perform problem solving in class to develop skills.

Global Objectives

By the end of the course, students will have:

1. Developed an understanding of the fundamental logic of the R programming language.

2. Developed an understanding of the current state and prospects for R in relation to other alternatives for data science and bioinformatics

3. Developed an in-depth understanding of the central paradigms of R programming

4. Gained a basic understanding of some of the key issues surrounding data science aspects of R programming

Learning Objectives

By the end of this course, students will have:

- Developed knowledge of the strengths and weaknesses of using R for programming and data analysis.
- Developed a knowledge of current paradigms for data analysis, including reproducible research approaches
- Experienced programming and solving problems using fundamental features of R
- Experienced programming using a variety of paradigms and packages in R, especially widely used current packages (e.g. the "tidyverse")
- Developed facility with advanced graphical programming in R
- Developed knowledge of the Bioconductor set of packages

Required Textbooks

There are no required textbooks. References to appropriate materials for lectures will be given at the first class meeting.

A Note regarding readings

A list of required readings for all course sections will be outlined on D2L and links and documents will be made available, where possible. Required readings have been chosen carefully to inform you and enhance the lecture material**. Students are REQUIRED to complete assigned readings BEFORE each lecture. Readings and sources will be discussed at the first lecture.** Instructors will proceed in class on the assumption that students have read completely the assigned readings. Students should be aware that many of the readings they will be assigned may be of an unfamiliar nature and style. <u>Students should allot sufficient time to allow for several reads of the assigned material.</u>

Evaluation

The University policy on grading and related matters is described in section F.2 of the 2017-2018 Calendar.

In determining the overall grade in the course the following weights will be used:

- 40% in class participation and performance, including performance on in-class problems
  - This addresses all components of the learning objectives
- 10% one assignment
  - This addresses all components of the learning objectives
- 50% final project
  - This addresses all components of the learning objectives
  - Note that this project component encompasses writing (see next section)

A student's final grade for the course is the sum of the separate components. It is not necessary to pass each component separately in order to pass the course.

A Note regarding writing with respect to the assignment, in-class exercises, and the final project:

Writing skills are important to academic study in all disciplines. In keeping with the University of Calgary's emphasis on the importance of academic writing in student assignments (section E.2 of 2017-18 Calendar), writing is emphasized, and the grading thereof in determining a student's mark in this course. The Bachelor of Health Sciences values excellence in writing. Competence in writing entails skills in crafting logical, clear, coherent, non-redundant sentences, paragraphs and broader arguments, as well as skills with the mechanics of writing (grammar, spelling, punctuation). The University of Calgary offers a number of instructional services through the Students' Success Centre's Writing Support Services (http://www.ucalgary.ca/writingsupport/) for students seeking feedback on assignments or seeking to improve their general writing skills. Students are **strongly encouraged** to take advantage of these programs.

Grading Scheme:

A+ 97-100%	B+ 80-84%	C+ 65-69%	D+ 54-56%
A 90-96%	B 75-79%	C 60-64%	D 50-53%
A- 85-89%	B- 70-74%	C- 57-59%	F 0-49%

Missed Components of Term Work:

Late assignments will be accepted at a 20% per day late penalty. Assignments will **NOT** be accepted more than 72 hours after the posted deadline and students failing to submit any assignment within this time frame will receive a mark of zero. **Students who miss a class will receive a mark of zero for that class unless the instructor has been previously notified.** The only exceptions to this are those in keeping with the University Calendar (illness, religious conviction, or domestic affliction) that are received in writing and with supporting documentation. Please be advised that students should notify the instructor before the assignment deadline to discuss.

Desire2Learn (D2L)

Desire 2 Learn is located on the University of Calgary server and will be used extensively for communication with students. **It is the student's responsibility to ensure that s/he gets all posted communications and documents and that s/he receives emails sent by instructors or fellow students through D2L.** Only your @ucalgary.ca email address may be linked to D2L. Please ensure that you are regularly checking your @ucalgary.ca account.

If you need help accessing or using D2L, please visit the Desire2Learn resource page for students: http://elearn.ucalgary.ca/d2l-student/.

Policies Governing the Course:

Attendance

Given the large class performance mark, it is essential that students attend each meeting of this class, unless under conditions indicated above.

Students are expected to take notes during each session and should not rely solely on handout material supplied by the instructors.

Electronic Devices

The Bachelor of Health Sciences program aims to create a supportive and respectful learning environment for all students. Research studies have found that student use of electronic devices (laptops, tablets, etc) in the classroom negatively affects the learning of both the user and those sitting nearby. Inappropriate use of laptops is also disruptive to your fellow classmates and disrespectful to the lecturer. The use of laptops and other electronic note-taking devices is permitted; however, their use in the classroom should be for course-related work/note-taking only. Please do **NOT surf the web, check email or do other unrelated work**. Students who use their laptops inappropriately or are otherwise disruptive during lectures will be asked to leave.

Cell phones (or similar devices) should **be turned off** (not merely silent) upon entering the classroom. Sending/receiving text messages or leaving the class to take calls is disruptive to the entire class and will not be tolerated unless absolutely necessary. Students who disregard this

rule during lectures or tutorials will be asked to leave. These items are not permitted under any circumstance during exams/quizzes, etc.

Copyright
It is the responsibility of students and professors to ensure that materials they post or distribute to others comply with the Copyright Act and the University's Fair Dealing Guidance for Students (library.ucalgary.ca/files/library/guidance_for_students.pdf). Further information for students is available on the Copyright Office web page (http://library.ucalgary.ca/copyright)

A Note Regarding Instructor Intellectual Property
Generally speaking, course materials created by professor(s) (including course outlines, presentations and posted notes, labs, case studies, assignments and exams) remain the intellectual property of the professor(s). These materials may **NOT** be reproduced, redistributed or copied without the explicit consent of the professor. **The posting of course materials to third party websites such as note-sharing sites without permission is prohibited**. Sharing of extracts of these course materials with other students enrolled in the course **at the same time** may be allowed under fair dealing.

Academic Accommodations Based on Disability or Medical Condition
It is the student's responsibility to register with Student Accessibility Services to be eligible for formal academic accommodation in accordance with the Procedure for Accommodations for Students with Disabilities (https://www.ucalgary.ca/policies/files/policies/procedure-for-accommodations-for-students-with-disabilities_0.pdf). If you are a student who may require academic accommodation and have not registered with Student Accessibility Services, please contact their office at (403) 220-8237; http://www.ucalgary.ca/access/. Students will be provided with all necessary accommodations to ensure equal opportunity to succeed in this course. Please provide the instructor your accommodation letter from Student Accessibility Services within 14 days after the start of this course so that all needed arrangements for exams and assignments can be made.

Accommodations on Protected Grounds other than Disability
Students who require an accommodation in relation to their coursework based on a protected ground other than disability, should communicate this need, preferably in writing, to the designated BHSc program contact, Mrs. Jennifer Logan (jljlogan@ucalgary), or to Dr. Ebba Kurz, Associate Dean, Undergraduate Health and Science Education, Cumming School of Medicine. Students who require an accommodation unrelated to their coursework or the requirements for a graduate degree, based on a protected ground other than disability, should communicate this need, preferably in writing, to the Vice-Provost (Student Experience). For additional information on support services and accommodations for students with disabilities, visit www.ucalgary.ca/access/.

Academic Misconduct
The University of Calgary is committed to the highest standards of academic integrity and honesty. The University of Calgary has created rules to govern all its members regarding the creation of knowledge and the demonstration of knowledge having been learned. These rules

are contained principally in Sections J to L of the University of Calgary Calendar. Students are expected to be familiar with these standards and to uphold the policies of the University in this respect. The Calendar also stipulates the penalties for violating these rules. Please know that the University and the Cumming School of Medicine take these rules seriously. **All incidences of academic dishonesty in this course, such as cheating and plagiarism, will be reported to the Associate Dean for investigation;** infractions will be noted on the record of a student found to be guilty.

Recording of Lectures
Audio or video recording of lectures is prohibited except where explicit permission has been received from the instructor.

Other Important Information

Freedom of Information and Protection of Privacy Act
This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIP); students should identify themselves on written assignments (exams and term work) by their name and ID number on the front page and ID on each subsequent page. Work assigned to you by your course instructor will remain confidential unless otherwise stated before submission. The assignment cannot be returned to anyone else without your expressed permission to the instructor. Grades will be made available on an individual basis and students will not have access to other students' grades without expressed consent. Similarly, any information about yourself that you share with your course instructor will not be given to anyone else without your permission. See http://www.ucalgary.ca/policies/files/policies/privacy-policy-2011.pdf for more information.

Appeals
If there is a concern with the course, academic matter or a grade, first communicate with the instructor. If these concerns cannot be resolved, students can proceed with an academic appeal, as per Section I of the University Calendar. Students must follow the official reappraisal/appeal process and may contact the Student Ombuds' Office (http://www.ucalgary.ca/ombuds) for assistance with this and with any other academic concerns, including academic and non-academic misconduct. Students should be aware that concerns about graded term work may only be initiated **within 15 days** of first being notified of the grade.

Resources for Support of Student Learning, Success, Safety and Wellness

Student Success Centre	http://www.ucalgary.ca/ssc/
Student Wellness Centre	http://www.ucalgary.ca/wellnesscentre/
Distress Centre	http://www.distresscentre.com/
Library Resources	http://library.ucalgary.ca

Wellness and Mental Health Resources
The University of Calgary recognizes the pivotal role that student mental health plays in physical health, social connectedness and academic success, and aspires to create a caring and

supportive campus community where individuals can freely talk about mental health and receive supports when needed. We encourage you to explore the excellent mental health resources available throughout the university community, such as counselling, self-help resources, peer support or skills-building available through the SU Wellness Centre (Room 370 MacEwan Student Centre, https://www.ucalgary.ca/wellnesscentre/services/mental-health-services) and the Campus Mental Health Strategy (http://www.ucalgary.ca/mentalhealth/).

Student Ombuds' Office
The Student Ombuds' Office supports and provides a safe, neutral space for students. For more information, please visit www.ucalgary.ca/ombuds/ or email ombuds@ucalgary.ca

Student Union (SU) Information
The SU Vice-President Academic can be reached at (403) 220-3911 or suvpaca@ucalgary.ca; the SU representatives for the Cumming School of Medicine can be reached at medrep@su.ucalgary.ca.

Emergency Evacuation/Assembly Points
Assembly points for emergencies have been identified across campus. Assembly points are designed to establish a location for information updates from the emergency responders to the evacuees; and from the evacuated population to the emergency responders. The primary assembly point for the Health Sciences Centre is the Health Research Innovation Centre (HRIC) Atrium. For more information, see the University of Calgary's Emergency Management website: http://www.ucalgary.ca/emergencyplan/assemblypoints.

Safewalk
Campus security will escort individuals, day or night, anywhere on campus (including McMahon Stadium, Health Sciences Centre, Student Family Housing, the Alberta Children's Hospital and the University LRT station). Call 403-220-5333 or visit http://www.ucalgary.ca/security/safewalk. Use any campus phone, emergency phone or the yellow phone located at most parking lot pay booths. Please ensure your personal safety by taking advantage of this service.

Class Schedule

The following is a list of topics for class, associated readings, and assignment / exam due dates. Please note that unforeseen circumstances may cause changes to the schedule with respect to the timing of topics and readings. Students will be notified of all changes in a timely manner by way of email and D2L announcements. The project and assignment due dates will not be altered.

NOTE: The project due date is 5 pm of the 4th day after the final class. Project format will be discussed in class. Project final materials should be by email submission to the instructor (mbieda@ucalgary.ca). It is the student's responsibility to assure that email submissions are successfully emailed and not rejected by the University of Calgary system. Alternative submission via cloud services will be discussed.

Date (MM/DD/YY)	Module / Topics	Instructor/Guest Lecturer	Assignments & Due Dates
9/14/17	1: Course overview; Rstudio and R basics	Bieda	
9/21/17	2: R basic data structures and simple statistics in R	Bieda	
9/28/17	3: R basic data operations , functions, and libraries	Bieda	Assignment #1 handout
10/5/17	4: R data structures – advanced manipulation	Bieda	
10/12/17	5: R data structures - objects, classes	Bieda	Assignment #1 due at start of class
10/19/17	6: The tidyverse and graphics in R	Bieda	
10/26/17	7: S3 and S4 introduction and basic usage	Bieda	
11/2/17	8: Advanced S3 and S4	Bieda	

11/9/17	9: Advanced R: various topics	Bieda	
11/16/17	10: Advanced R and Bioconductor packages	Bieda	
11/23/17	11: Project selection and initial presentation	Bieda	
11/30/17	12: Project update + advanced graphics	Bieda	
12/7/17	13: Reproducible research in R; comparison with Python data science packages	Bieda	Note: Project due 12/11/17 by 5 pm