UNIVERSITY of GUELPH

BINF*6890 Topics in Bioinformatics

Fall 2022
Section(s): C02

College of Biological Science
Credit Weight: 0.50
Version 1.00 - September 08, 2022

___

1 Course Details

1.1 Calendar Description

The course covers a breadth of knowledge of topics in bioinformatics, which may include, but are not limited to, programming languages and development, computing skills applicable to artificial intelligence and machine learning strategies, and multi-OMICs software packages and their applications in diverse biological fields. Additionally, critical thinking, communication, presentation, and collaboration skills are developed and fostered.

1.2 Course Description

Selected topics in bioinformatics will be covered. The course might focus on biological or informatics topics, or upon a mixture of both.

1.3 Timetable

Sept. 14 - Dec. 1: Wednesdays 12:30 am -3:20 pm

Module 1, Dr. Dirk Steinke (weeks 1-4) - in-person with remote (synchronous and recording) option

Module 2, Dr. Jennifer Geddes-McAlister (weeks 5-8) - in-person with remote (synchronous and recording) option

Module 3, Dr.Khurram Nadeem (weeks 9-12) - in-person with remote (synchronous and recording) option

Links for attending remote lectures will be available through Courselink.

1.4 Final Exam

This course does not have a final exam.

_____

2 Instructional Support

2.1 Instructional Support Team

Instructor:	Dirk Steinke
Email:	dsteinke@uoguelph.ca
Telephone:	+1-519-824-4120 x53759
Office:	CBG 109

Instructor:	Jennifer Geddes-McAlister
Email:	jgeddesm@uoguelph.ca
Telephone:	+1-519-824-4120 x52129
Office:	SSC 4457

Instructor:	Khurram Nadeem Department of Mathematics & Statistics
Email:	nadeemk@uoguelph.ca
Telephone:	+1-519-824-4120 x53136
Office:	MacNaughton 517

_____

3 Learning Resources

3.1 Required Resources

Required readings (Article)

At the beginning of each module, the instructors will post several key papers relating to that theme of the module. There may also be lecture videos or other course material that will be assigned throughout the course in order to supplement the lectures.

_____

4 Learning Outcomes

4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Go beyond correctly describing works to clearly articulating their relevance as well as shortcomings.

2. Evaluate methods described in studies to collect, analyze, and interpret biological data.

3. Demonstrate appreciation of systematic and high-quality scientific investigation and use inductive and deductive reasoning to define scientific research.

4. Communicate in visual and oral format and work collaboratively with diverse team members.

5. Communicate in written format and improve on the quality of writing through instructor feedback.

6. Appreciate the depth and breadth of bioinformatics and learn to think independently about bioinformatics tools and research. The course will expose the student to both well-established and cutting-edge material.

_____

5 Teaching and Learning Activities

5.1 Lecture

Weeks 1-4

Topics: **DR. DIRK STEINKE, INTEGRATIVE BIOLOGY**

Phylogenetics

- Phylogenies
  - Trees
  - Phylogenetics
  - Input data
- Molecular phylogenetics
  - Sequence alignment and clustering
  - Models of molecular evolution
  - Taxonomic classification and assignment

- Phylogenetic methods
  - Distance vs. Parsimony
  - Maximum likelihood and Bayesian Analysis
  - Coalescence methods

Weeks 5-8

Topics: **DR. JENNIFER GEDDES-MCALISTER, MOLECULAR AND CELLULAR BIOLOGY**

- Mass spectrometry-based proteomics
  - Background
  - Theory
  - Applications
  - Computational tools available
- Introduction to specific software tools
  - MaxQuant (mass spectrometry raw data processing)
  - Perseus (data analysis and visualization
- Practice data analysis on real proteomics datasets from the JGM lab
  - Run alignment and identification software
  - Visualize and assess data sets
  - Generate conclusions from the data
- Present your work to the group and discuss challenges/limitations/alternatives

Weeks 9-12

Topics: **DR. KHURRAM NADEEM, DEPARTMENT OF MATHEMATICS & STATISTICS**

Introduction of Probability and Statistics for Bioinformatics and Genetics

- Compute probability of various events using Venn

diagrams, tree diagrams, and the addition and multiplication rules. Describe the concepts of mutually exclusive events, conditional probability, dependent and independent events.

- Discuss the concepts of random variables, discrete and continuous probability distributions, and identify their use in developing statistical inference tools.
- Describe the concept of a sampling distribution, including central limit theorem, and its use in conducting statistical inference for population parameters.
- Hypothesis testing and confidence interval estimation. Discuss the concept of p-values in hypothesis testing.
- Least square estimation for the simple linear regression model. Residuals and residual plots, assumptions, correlation coefficient, coefficient of determination, statistical inference on the slope.
- Fisher exact test for Hardy-Weinberg equilibrium. Discuss the concept and application of Chi-Square tests in genetics.

_____

6 Assessments

This class is divided into three modules. Average marks in the three modules will be similar, but note that we expect the quality of work to earn a certain mark will increase during the course. Considering feedback and improving professional skills (writing, presenting, discussing) over the course of the three modules is an important component of this course.

6.1 Marking Schemes & Distributions

Written assignments: 20% + 20% + 33% = 73%

Oral presentations: 2x10% = 20%

Participation: 7%

Total: 100%

6.2 Assessment Details

Oral Presentations (Module 1 and 2) (20%)
Date: Oct 5, Nov 2 during assigned lecture time, In-class
Learning Outcome: 1, 2, 3, 4, 6

Each student will deliver 3 oral presentations during this course (one for each of the three themes) as part of a project team. Presentations will be held during the last class for each theme. Presentations will be delivered in groups of 3 in the same remote format used for class lectures. The presentation must be submitted to the Dropbox no later than 10 am on the day **prior to** the presentation.

Students must choose a different team for each presentation. Presentations should be 15 minutes in length, with an additional 5 min expected for questions. Active listening and participating through asking questions and discussing are also important.

Presentations will be on a given topic, not a specific paper. It is expected that results from several core papers will be incorporated into the presentations. It would be most effective for this to be in the form of synthesis of subject matter, rather than just listing a series of papers (i.e., not Smith studied X; Jones studied Y, etc.).

As a guideline, presentations may address the following questions:

- Why is this topic important scientifically and to society?
- What are some of the key recent developments in this topic?
- What are the key outstanding questions and areas of active research?
- How has bioinformatics contributed to advancing the topic?

The instructors will provide several example topics for each theme. These are intended to serve as a guide regarding suitable topics and scope. Students will sign up for a theme at the end of the first class in each of the three themes. Proposing a different topic is welcome, but you must obtain approval from the instructor first.

Writing Assignments - Paper critique (Module 1 and 2) (40%)
   Due: October 12, November 9 at 10 am
   Learning Outcome: 1, 2, 3, 5, 6

At the beginning of each module, the instructors will post several key papers relating to that theme of the module. Everyone should read all of these papers and select 1 for a detailed critique, which is your written assignment. Your critique will be graded on how well it addresses the following points if they are appropriate to a paper.

- Explains the objective of the work.
- Explains either the biological hypothesis of the work or the computational objective.
- Summarizes and explains the experiments performed and/or the algorithmic innovations presented in the paper.
- Critiques the conclusions of the paper. Do they support the biological claims made in the paper? If the paper is about a tool, is it clear how to use the tool and what it does?
- What additional work would improve the paper?
- What is the role of the work presented in the paper in the larger context of biological and bioinformatic research?

Critiques should be no more than 4 pages in length (double-spaced, 12-point font, 2.54 cm standard margins) and contain a reference list (usually 8+). We encourage to go beyond the assigned readings to assess the significance of your chosen paper. You are also encouraged to include your own figures or tables (such as a figure demonstrating a concept or short summary table comparing studies or expectations). If you include a published figure this must be clearly cited. Note that the reference list and any figures or tables are not included in the 4 page-limit.

Grading will be performed considering the following criteria: level of understanding of the paper, clarity of explanations, quality and correctness of the prose, and synthesis (e.g., placing the work in context and interpreting the broader significance of the work as well as outstanding research questions).

Written assignments are individual and must be your own work and prose. Quotations

should be used sparingly, if at all (i.e., only for profound quotes or definitions). All submissions will be assessed using Turnitin®. We encourage peer review (by your classmates) and commenting prior to submission.

Participation (Module 1 and 2) (7%)
Date: Through the course., In-class

High attendance rates are assumed, and this component of the grade is for participation beyond attendance. Students are expected to come to class prepared, having already read the required readings for that unit. Active listening during peer presentations is important, followed by asking questions and participating in discussions. Class participation includes in-class problem solving, leading and participating in class discussions and tutorials, and actively listening and asking questions following the lectures and presentations of peers.

Module 3 assignments (33%)

	Weight	Due
Assignment 1	8%	Nov. 18
Assignment 2.	10%	Nov. 25
Assignment 3.	15%.	Dec. 9

6.3 Late Policy

Late assignments will receive a 10% deduction per day. Students are encouraged to discuss the potential for a late assignment with the instructor prior to the due date as circumstances will be assessed on a case-by-case basis. Additionally, students should consult the University policy below for further guidance.

https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/sec_d0e2221.shtml

_____

7 College of Biological Science Statements

7.1 Wellness

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.
- Student Health Services is located on campus and is available to provide medical attention.
- For support related to stress and anxiety, besides 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.selfregulationskills.ca/

7.2 Personal information

Personal information is collected under the authority of the University of Guelph Act (1964), and in accordance with Ontario's Freedom of Information and Protection of Privacy Act (FIPPA) http://www.e-laws.gov.on.ca/index.html. This information is used by University officials in order to carry out their authorized academic and administrative responsibilities and also to establish a relationship for alumni and development purposes.

For more information regarding the Collection, Use and Disclosure of Personal Information policies please see the Undergraduate Calendar. (https://www.uoguelph.ca/registrar/calendars/undergraduate/current/intro/index.shtml)

7.3 Course Offering Information Disclaimer

Please note that course delivery format (face-to-face vs online) is subject to change up to the first-class day depending on requirements placed on the University and its employees by public health bodies, and local, provincial and federal governments. Any changes to course format prior to the first class will be posted on WebAdvisor/Student Planning as they become available.

8 University Statements

8.1 Email Communication

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

8.2 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. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Graduate Calendar - Grounds for Academic Consideration
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions
https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml

8.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml

Graduate Calendar - Registration Changes
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml

Associate Diploma Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml

8.4 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.

8.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to make a booking at least 14 days in advance, and no later than November 1 (fall), March 1 (winter) or July 1 (summer). Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time.

For Guelph students, information can be found on the SAS website
https://www.uoguelph.ca/sas

For Ridgetown students, information can be found on the Ridgetown SAS website
https://www.ridgetownc.com/services/accessibilityservices.cfm

8.6 Academic Integrity

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 encourages academic integrity. 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.

Undergraduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

Graduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

8.7 Recording of Materials

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

8.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars
https://www.uoguelph.ca/academics/calendars

8.9 Disclaimer

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings, changes in classroom protocols, and academic schedules. Any such changes will be announced via CourseLink and/or class email.

This includes on-campus scheduling during the semester, mid-terms and final examination schedules. All University-wide decisions will be posted on the COVID-19 website

(https://news.uoguelph.ca/2019-novel-coronavirus-information/) and circulated by email.

8.10 Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g.. final exam or major assignment).

8.11 Covid-19 Safety Protocols

For information on current safety protocols, follow these links:

- https://news.uoguelph.ca/return-to-campuses/how-u-of-g-is-preparing-for-your-safe-return/
- https://news.uoguelph.ca/return-to-campuses/spaces/#ClassroomSpaces

Please note, these guidelines may be updated as required in response to evolving University, Public Health or government directives.

_____