Computation for 21st Century Biologists – BIOL 4590

Department of Life Sciences

Fall 2020

A. COURSE INFORMATION

Course number/section: BIOL 4590
Class meeting time: F 1-3:30
Class location: WEBEX
Course Website: GitHub Organization for Course
GitHub Repository for Course
Black Board

B. INSTRUCTOR INFORMATION

Instructor: Dr. Christopher E. Bird
Office location: TH 234, WebEx Office
Office hours: W-F 3-5
Telephone: 361-825-6024 (office), 361-443-5676 (cell)
e-mail: chris.bird@tamucc.edu
Appointments: arrange via email or text

C. COURSE DESCRIPTION

Catalog Course Description
NA – Special Topics

Extended Course Description
This is a 3-credit course for upper-level undergraduates that introduces the powerful open-source computing tools that are used in biological research for the creation, organization, manipulation, processing, analysis, and archiving of "big data". This course is designed to prepare and enable students to use computational tools for bioinformatic applications in advanced courses and independent research projects. The primary topics covered are: data formats and repositories, command line Linux computing and scripting, regular expressions, super-computing, computer programming with PYTHON and R, data visualization with R, version control and dissemination of scripts and programs with GIT, and typesetting with markdown languages.

Whether you want to learn basic data handling skills for your research project or you are curious about a career in bioinformatics and "big data", this course will provide you with the proper foundations.

D. PREREQUISITES AND COREQUISITES

Prerequisites
While not a formal requirement, it is assumed that students have a firm command of basic algebra.

Corequisites
NA

E. REQUIRED TEXTBOOK(S), READINGS AND SUPPLIES

Required Textbook(s)

Computing skills for biologists: a toolbook. Allesina & Wilmes 2019.

Optional Textbook(s) or Other References
R for Data Science. Grolemund and Wickham. (Free)

Supplies

A computer designed for content creation (Linux, OSX, Windows, not chrome, not iOS, not Android).

F. STUDENT LEARNING OUTCOMES AND ASSESSMENT

Assessment is a process used by instructors to help improve learning. Assessment is essential for effective learning because it provides feedback to both students and instructors. A critical step in this process is making clear the course's student learning outcomes that describe what students are expected to learn to be successful in the course. The student learning outcomes for this course are listed below. By collecting data and sharing it with students on how well they are accomplishing these learning outcomes students can more efficiently and effectively focus their learning efforts. This information can also help instructors identify challenging areas for students and adjust their teaching approach to facilitate learning.

Upon the successful completion of this course, students should be able to:

1. ***Recognize, describe, and organize data into standard biological data structures***
2. ***Locate scientific data repositories and extract data***
3. ***Operate UNIX/LINUX OS from command line***
4. ***Construct and modify computer programming/scripting logic structures for processing biological data***
5. ***Use version control software (git)***
6. ***Describe and use regular expressions for pattern matching***
7. ***Typeset with LaTeX or MarkDown***
8. ***Use the most popular open-source tools for biological data manipulation***
    a. ***Shell scripting (bash)***
    b. ***Scientific computing (python)***
    c. ***Statistical computing (R)***
    d. ***Tool repositories***

G. INSTRUCTIONAL METHODS AND ACTIVITIES

Computation for 21st Century Biologists will convene on Fridays at 1pm for 2.5 hours. Class periods will involve interactive lectures that require each student to have a computer designed for content creation (Linux, OSX, Windows, not chrome, not iOS, not Android). Homework exercises will embellish upon concepts addressed in lecture. **Participation** involves attending lectures and performance on unannounced quizzes. Weekly **Assignments** will be given to reinforce concepts covered in lectures and encourage students to start using computational tools. **Exams** will be used to evaluate comprehension of the materials covered in lectures and assignments. For *undergraduates only*, a comprehensive **Final Exam** will be used to assess the learning objectives detailed above.

H. MAJOR COURSE REQUIREMENTS AND GRADING

Student learning outcomes will be assessed using in class exercises, semester-long assignments, and exams. Your final grade will be based on the percentage you earn out of the total possible points, extra points may be built into exams or other assignments. It is also possible to lose points by turning in assignments late. Statistical manipulations to adjust grades, *if* used (at the Instructor's discretion), will be performed for each exam individually and all assignments in aggregate. A standard grading scale will be used:

A = 90 - 100 %
B = 80 - 89.9 %
C = 70 - 79.9 %
D = 60 - 69.9 %
F = 0 - 59.9 %

Undergraduates:

ACTIVITY	% of FINAL GRADE
Participation	15
Assignments	40
Exam 1	12.5
Exam 2	12.5
Final Exam	20

I. COURSE CONTENT/SCHEDULE

Date	Lecture Topic	HW Due
	Theme I: Welcome to the Matrix	
Wk 0	1. Course overview 2. Biological Data Repositories, Structures, Formats 3. Computer set up	

Wk 1	Linux Boot Camp I (Ch 1) 1. UNIX philosophy 2. Navigating/creating/manipulating directories & files 3. How to get help: man pages 4. Basic commands: cd, ls, cp, mv, mkdir, rm, tr, cut, cat, head, tail, 5. Commands useful for manipulating data files in text streams	Assignment 0
Wk 2	Linux Boot Camp II (Ch 1) 1. Wildcards, substituting characters, permissions, sudo 2. Pattern matching with grep & regex 3. Intro to Computer Programming: Shebang!, Scripting, For Loops	Assignment 1
Wk 3	Linux Boot Camp III (Not covered in book) 1. More Computer Programming with bash 2. Logic: if-then-else; looping with while, and GNU parallel 3. Functions: diy commands 4. Advanced text stream manipulation: sed, paste, …	Assignment 2 SuperComputer Acct
Wk 4	Version Control & Supercomputing (Ch 2) 1. Linux repositories and tools for biologists 2. Version control with git 3. Super computing, ssh	Assignment 3
	Theme II: Programming the Matrix	
Wk 5	Python Boot Camp I (Ch 3) 1. Intro to Python 2. Data structures 3. Functions 4. Decision logic and loops 5. Reading and writing files	**Exam 1** Install Anaconda & Jupyter
Wk 6	Python Boot Camp II (Ch 4) 1. Writing code 2. Modules & Program Structure 3. Errors and exceptions 4. Debugging 5. Testing & Profiling	Assignment 5
Wk 7	Scientific Computing w/ Python (Ch 6) 1. NumPy and SciPy 2. Pandas 3. Biopython 4. Other modules	Assignment 6
Wk 8	Scientific Typesetting w/ Latex (Ch 7) 1. Latex document structure 2. Typsetting	Assignment 7

	3. Latex packages for biologists	
	Theme III: Wrangling and Visualizing Data	
Wk 9	R Boot Camp I (Ch 8) 1. R Philosophy 2. Similarities and differences from bash and python 3. Installing R & R Studio 4. R data structures 5. Reading and writing data 6. Scripting 7. Logic structures	**Exam 2** Install R & R Studio
Wk 10	R Boot Camp II (Ch 8) 1. Functions 2. Libraries 3. Random numbers 4. Vectorize 5. Debugging 6. Stats 7. Plots 8. Packages	Assignment 9
Wk 11	R Boot Camp III (Ch 9) 1. tidyverse 2. Manipulating data 3. Computing statistics 4. Wrangling data 5. Visualization of data	Assignment 10
Wk 12	R Boot Camp IV 1. Advanced tidyverse, pipelines	Assignment 11
Wk 13	Putting It All Together (Ch 11)	Assignment 12
Final	**Final Exam: Becoming THE ONE**	

J. COURSE POLICIES

COVID-19

Face Coverings - (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Extra masks will be made available if needed.

Attendance/Tardiness: Attendance is expected. If you are late, don't make a disturbance and you will be responsible for catching yourself up to where we are.

Late Work and Make-up Exams: 10% of total possible score is deducted per day late. Inform professor as soon as you find out that you will miss and exam. Make arrangements with professor for make-up.

Cell Phone, Tablet, and Laptop Use: Required

Food in Class: food is not allowed in computer labs

Missed Exam: let me know ahead of time, when you realize you will miss an exam

Participation: Required

K. COLLEGE AND UNIVERSITY POLICIES

- **Academic Integrity (University)**
  University students are expected to conduct themselves in accordance with the highest standards of academic honesty. Academic misconduct for which a student is subject to penalty includes all forms of cheating, such as illicit possession of examinations or examination materials, falsification, forgery, complicity or plagiarism. (Plagiarism is the presentation of the work of another as one's own work.) In this class, academic misconduct or complicity in an act of academic misconduct on an assignment or test will result in a failing grade.

- **Classroom/Professional Behavior**
  Texas A&M University-Corpus Christi, as an academic community, requires that each individual respect the needs of others to study and learn in a peaceful atmosphere. Under Article III of the Student Code of Conduct, classroom behavior that interferes with either (a) the instructor's ability to conduct the class or (b) the ability of other students to profit from the instructional program may be considered a breach of the peace and is subject to disciplinary sanction outlined in article VII of the Student Code of Conduct. Students engaging in unacceptable behavior may be instructed to leave the classroom. This prohibition applies to all instructional forums, including classrooms, electronic classrooms, labs, discussion groups, field trips, etc.

- **Statement of Civility**
  Texas A&M University-Corpus Christi has a diverse student population that represents the population of the state. Our goal is to provide you with a high quality educational experience that is free from repression. You are responsible for following the rules of the University, city, state and federal government. We expect that you will behave in a manner that is dignified, respectful and courteous to all people, regardless of sex, ethnic/racial origin, religious background, sexual orientation or disability. Behaviors that infringe on the rights of another individual will not be tolerated.

- **Deadline for Dropping a Course with a Grade of W (University)**
  I hope that you never find it necessary to drop this or any other class. However, events can sometimes occur that make dropping a course necessary or wise. ***Please consult with your academic advisor, the Financial Aid Office, and me, before you decide to drop this course.*** Should dropping the course be the best course of action, you must initiate the process to drop the course by going to the Student Services Center and filling out a course drop form. Just stopping attendance and participation WILL NOT automatically result in your being dropped from the class. Please consult the Academic Calendar (http://www.tamucc.edu/academics/calendar/) for the last day to drop a course.

- **Grade Appeals (College of Science and Engineering)**
  As stated in University Procedure 13.02.99.C0.03, Student Grade Appeal Procedures, a student who believes that he or she has not been held to appropriate academic standards as outlined in the class syllabus, equitable evaluation procedures, or appropriate grading, may appeal the final grade given in the course. The burden of proof is upon the student to demonstrate the appropriateness of the appeal. A student with a complaint about a grade is required to first discuss the matter with the instructor. For complete details, including the responsibilities of the parties involved in the process and the number of days allowed for completing the steps in the process, see University Procedure 13.02.99.C0.03, Student Grade Appeal Procedures. These documents are accessible through the University Rules website at http://academicaffairs.tamucc.edu/rules_procedures/assets/13.02.99.c0.03_student_grade_appeals.pdf). For assistance and/or guidance in the grade appeal process, students may contact the chair or director of the appropriate department or school, the Office of the College of Science and Engineering Dean, or the Office of the Provost.

- **Disability Services**
  The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please call (361) 825-5816 or visit Disability Services in Corpus Christi Hall 116.

  If you are a returning veteran and are experiencing cognitive and/or physical access issues in the classroom or on campus, please contact the Disability Services office for assistance at (361) 825-5816.

  http://disabilityservices.tamucc.edu/

  - **Civil Rights Complaints**
    Texas A&M University-Corpus Christi is committed to fostering a culture of caring and respect that is free from discrimination, relationship violence and sexual misconduct, and ensuring that all affected students have access to services. For

information on reporting Civil Rights complaints, options and support resources (including pregnancy support accommodations) or university policies and procedures, please contact the University Title IX Coordinator, Sam Ramirez (Samuel.ramirez@tamucc.edu) or Deputy Title IX Coordinator, Rosie Ruiz (Rosie.Ruiz@tamucc.edu) x5826, or visit website at Title IX/Sexual Assault/Pregnancy.

Limits to Confidentiality. Essays, journals, and other materials submitted for this class are generally considered confidential pursuant to the University's student record policies. However, students should be aware that University employees, including instructors, are not able to maintain confidentiality when it conflicts with their responsibility to report alleged or suspected civil rights discrimination that is observed by or made known to an employee in the course and scope of their employment. As the instructor, I must report allegations of civil rights discrimination, including sexual assault, relationship violence, stalking, or sexual harassment to the Title IX Coordinator if you share it with me.

These reports will trigger contact with you from the Civil Rights/Title IX Compliance office who will inform you of your options and resources regarding the incident that you have shared. If you would like to talk about these incidents in a **confidential** setting, you are encouraged to make an appointment with counselors in the University Counseling Center.

- **Statement of Academic Continuity**
  In the event of an unforeseen adverse event, such as a major hurricane and classes could not be held on the campus of Texas A&M University–Corpus Christi; this course would continue through the use of Blackboard and/or email. In addition, the syllabus and class activities may be modified to allow continuation of the course. Ideally, University facilities (i.e., emails, web sites, and Blackboard) will be operational within two days of the closing of the physical campus. However, students need to make certain that the course instructor has a primary and a secondary means of contacting each student.

L. OTHER INFORMATION

- **Academic Advising**
  The College of Science & Engineering requires that students meet with an Academic Advisor as soon as they are ready to declare a major. The Academic Advisor will set up a degree plan, which must be signed by the student, a faculty mentor, and the department chair. Meetings are by appointment only; advisors do not take walk-ins. Please call or stop by the Advising Center to check availability and schedule an appointment. The College's Academic Advising Center is located in Center for Instruction 350 or can be reached at (361) 825-3928.

GENERAL DISCLAIMER

I reserve the right to modify the information, schedule, assignments, deadlines, and course policies in this syllabus if and when necessary. I will announce such changes in a timely manner during regularly scheduled lecture periods.