MATH 5370

Mathematical and Computational Methods in Bioinformatics
CRN: 17130
Term: Fall 2023
Credit Hours: 3
Instructor: Dr. Anass Bouchnita
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Instructor office: Bell Hall 202
Time and location: MW from 1 p.m. to 1:30 p.m. in Bell Hall 130
Office hours: Thursdays from 1:30 to 2:50 pm.

Prerequisites

The course is targeted towards students with training in biology. It assumes that all students have basic knowledge of cellular and molecular biology.

Course description

Bioinformatics is a multidisciplinary field that leverages tools and techniques from computer science, mathematics, biology, and statistics to understand and interpret biological data, especially molecular and genomic information. Tools from computer science and mathematics are essential in bioinformatics because they facilitate data analysis, visualization, algorithm development, as well as the modeling and simulation of living systems.

This course aims to equip students with a background in biology with the programming and discrete mathematics tools required for bioinformatics training. The course is divided into two parts: one focuses on algorithms and programming, and the other introduces key concepts in discrete mathematics. Students will enhance their programming and mathematical skills through hands-on sessions, gaining the opportunity to address biological questions using the methods they learn.

The course aims to introduce students with a background in biology to the concept of algorithms and their applications in bioinformatics. It will also allow them to gain programming skills and become familiar with Python, one of the most widely used programming languages. The students will learn how to use variable types, functions, loops, lists and others. They will be initiated to solving real-life problems by writing their own algorithms and implementing them as computer programs. In the second part, the course will introduce students to key concepts in discrete mathematics such as relations, graphs, trees, and functions, which will allow them to understand various problems in bioinformatics. They will learn to solve combinatorial problems using specific algorithms.

By tackling bioinformatics problems and using programming and discrete math tools to address them, students will develop crucial problem-solving skills and foster their interdisciplinary thinking. They will

be introduced to algorithmic thinking and will be empowered to further hone their coding and mathematical abilities independently.

Learning objectives

Upon successful completion of the course, the students will be able to achieve the following outcomes:

- **Develop Programming Skills**: Acquire the basics of algorithmic thinking and gain proficiency in programming relevant to bioinformatics tasks.
- **Understand and Apply Discrete Mathematics**: Recognize the fundamental concepts of discrete mathematics and apply them in bioinformatics scenarios.
- **Apply Programming and Discrete Math Techniques to Real Biological Questions**: Use the programming and mathematical tools learned to investigate and answer real-world biological questions.

Learning modules

The course will consist of weekly lectures that contain hands-on programming or exercise solving sessions. A tentative schedule of the course contents is provided in Table 1.

Course materials

- For the first part, we will use the following freely available resource to learn programming with Python:
  Allen B. Downey. *Think Python: How to Think Like a Computer Scientist.*
  https://www.greenteapress.com/thinkpython/html/

  Examples related to bioinformatics will be taken from other textbooks such as:
  Bassi, Sebastian. *Python for bioinformatics*. Chapman and Hall/CRC, 2017.

- For the second part, we will cover chapters 2, 3, 4, 5, 8, and appendix A of the following textbook:
  John A. Dossey et al. *Discrete Mathematics* (5th Edition). Addison Wesley

Course assignments and grading

The final grade will be calculated based on attendance and participation, the six quizzes, the mini project, the midterm exam and the two exams. The two quizzes with the lowest scores will be dropped. The grade will be calculated based on the final score as follows:

1000-800 = A; 800-600 = B; 600-400 = C; 400-200 = D; 200 and Below = F

The final score will be calculated as the weighted sum of the grades obtained in the following tests:

o 150 Points: attendance and participation

- o 150 Points: quizzes
- o 150 Points: mini-project (algorithms and programming)
- o 150 Points: midterm exam (discrete mathematics)
- o 200 Points: programming final exam
- o 200 Points: discrete mathematics final exam

Table 1: Tentative schedule of the course modules and examinations. The schedule is subject to change depending on the achievement of the learning outcomes. Any changes will be announced through e-mail or over Blackboard.

Week	Content
Aug 28 - Aug 30	Algorithms and their application in bioinformatics + introduction to Python
Sep 4 - Sep 6	Types, values, expressions; variables and binding
Sep 11 - Sep 13	Functions, parameters, arguments, and outputs
Sep 18 - Sep 20	Recursive and iterative functions
Sep 25 - Sep 27	List, dictionaries, tuples + mini-project
Oct 2 - Oct 4	Files, libraries, coding practices, debugging
Oct 9 - Oct 11	Object-oriented programming
Oct 16 - Oct 18	Course review + final programming exam
Oct 23 - Oct 25	Guest lecture + introduction to discrete math and combinatorial problems in bioinformatics
Oct 30 - Nov 1	Set, relations, and functions
Nov 6 - Nov 8	Logic and proofs
Nov 13 - Nov 15	Graphs, midterm exam
Nov 20 - Nov 22	Trees, matching
Nov 27 - Nov 29	Recurrence relations and generating functions
Dec 4 - Dec 6	Discrete math part review + final discrete math exam

Technology requirements

Course contents will be delivered via the Blackboard learning management system. Communication between students and the instructor will be mediated by the Blackboard discussion board or using UTEP email accounts. The student must have the last version of a stable browser like Google Chrome or Mozilla Firefox to explore Blackboard. If you still encounter any difficulties, update your browser, clear your

cache, or use a different browser. The Blackboard software will be used for quizzes, surveys, announcements, and additional course material. ADA students are advised to use word-processing software like Microsoft Office programs which is available for free via the UTEP Microsoft Office Portal. In addition, please reach out at the beginning of the course to accommodate the course for you. A tutorial for this software is available upon notice.

Given the computational nature of the course, computers with at least Core 2 duo and 8gb of RAM are required. The following software is also necessary for the completing of the learning activities:

- Word and powerpoint for preparing reports, presentations, and papers.
- Python interpreter (we will use version 3.9.X).
- Students may decide to use IDLE environments to edit and execute Python code, by default, we will be using notepad. Other IDEs can be used at the discretion of students.

IMPORTANT: If you encounter technical difficulties beyond your scope of troubleshooting, please contact the UTEP Help Desk as they are trained specifically in assisting with the technological needs of students. Please do not contact me for this type of assistance. The Help Desk is much better equipped than I am to assist you!

Course communication

This is an in-person course, we will use the following communication channels to stay in contact:

Office Hours: My office hours will be held during the following time:
Thursdays: 1-3 p.m. Mountain Time in person.

Email: UTEP email can be used if you have any inquiries regarding the course. I will attempt to answer within 24-48 hours. In the case the question requires a discussion, it is better to come to see me during office hours.

Netiquette

Online communication can be challenging because of the lack of body language and immediate feedback. Therefore, it is essential to follow some netiquette (network etiquette) guidelines to keep a positive and productive environment in the classroom. Failure to comply with these guidelines may result in disciplinary action.

o Communication should reflect polite consideration of others' ideas.
o Respect and courtesy must be provided to classmates and to the instructor at all times. No harassment or inappropriate postings will be tolerated.
o When reacting to someone else's message, address the ideas, not the person. Post only what anyone would comfortably state in a face-to-face situation.

o Blackboard is not a public internet venue; all postings to it should be considered private and confidential. Whatever is posted in these online spaces is intended for classmates and the instructor only. Please do not copy documents and paste them to a publicly accessible website, blog, or other space.

Attendance and participation

Attendance is necessary to successfully complete the quizzes and exams, and achieve a satisfactory grade. Further, students are expected to read the reading material before lectures and work through the examples covered after class. Attendance and participation are explicitly taken into the final grade. Students are expected to attend class and arrive on time. Absent students are responsible to find out the material and lab activities that need to be made up. Absences due to illness or other emergencies can be justified with appropriate documentation. Participation in the class covers asking questions and participating in class discussions.

Excused absences and drop policy

I will not drop you from the course. However, if you feel that you are unable to complete the course successfully, please let me know and then contact the Registrar's Office to initiate the drop process before the class drop deadline. If you do not, you are at risk of receiving an "F" for the course.

Accommodations policy

The University is committed to providing reasonable accommodations and auxiliary services to students, staff, faculty, job applicants, applicants for admissions, and other beneficiaries of
University programs, services and activities with documented disabilities in order to provide them with equal opportunities to participate in programs, services, and activities in compliance with sections 503 and 504 of the Rehabilitation Act of 1973, as amended, and the Americans with Disabilities Act (ADA) of 1990 and the Americans with Disabilities Act Amendments Act (ADAAA) of 2008. Reasonable accommodations will be made unless it is determined that doing so would cause undue hardship for the University. Students requesting accommodation based on a disability must register with the UTEP Center for Accommodations and Support Services (CASS). Contact the Center for Accommodations and Support Services at 915-747-5148, email them at cass@utep.edu, or apply for accommodations online via the CASS portal.

Scholastic integrity

Academic dishonesty is prohibited and is considered a violation of the UTEP Handbook of Operating Procedures. It includes, but is not limited to, cheating, plagiarism, and collusion. Cheating may involve copying from or providing information to another student, possessing unauthorized materials during a test, or falsifying research data on laboratory reports. Plagiarism occurs when someone intentionally or knowingly represents the words or ideas of another as one's own. Collusion involves collaborating with another person to commit any academically dishonest act. Any act of academic dishonesty attempted by a UTEP student is unacceptable and will not be tolerated. All suspected violations of academic integrity at The University of Texas at El Paso must be reported to the Office of Student Conduct and Conflict

Resolution (OSCCR) for possible disciplinary action. To learn more, please visit HOOP: Student Conduct and Discipline.

Copyright statement and course materials

All materials used in this course are protected by copyright law. The course materials are only for the use of students currently enrolled in this course and only for the purpose of this course. They may not be further disseminated.

Course resources

UTEP provides a variety of student services and support:

Technology Resources

Help Desk: Students experiencing technological challenges (email, Blackboard, etc.) can submit a ticket to the UTEP Helpdesk for assistance. Contact the Helpdesk via phone, email, chat, website, or in person if on campus.

Academic Resources

UTEP Library: Access a wide range of resources including online, full-text access to thousands of journals and eBooks plus reference service and librarian assistance for enrolled students.

Math Tutoring Center (MaRCS): Ask a tutor for help and explore other available discrete math resources.

Individual Resources

Military Student Success Center: Assists personnel in any branch of service to reach their educational goals.

Center for Accommodations and Support Services: Assists students with ADA-related accommodations for coursework, housing, and internships. Counseling and Psychological Services: Provides a variety of counseling services including individual, couples, and group sessions as well as career and disability assessments.