UNIVERSITY OF CENTRAL FLORIDA

CAP 6515: Algorithms in Computational Biology

Computer Science, CECS
3 Credit Hours

Course Syllabus***

Instructor:	Dr. Shaojie Zhang	Term:	Fall 2022
Office Location:	HEC-311	Class Meeting Days:	T/Th
Office Hours:	T/Th 2-2:50pm (in-person or via Zoom by appointment)	Class Meeting Time:	3:00-4:15pm
Phone:	407-823-6095	Class Location:	HEC-104
Email:	shzhang@cs.ucf.edu or Webcourses@UCF messaging	Course Modality:	P

GTA(s):	None	Email:	None

Course Description
This course will concentrate on computer science aspects of computational molecular biology and will emphasize the recent advances and open problems in the area. The computational techniques will include algorithms, graph theory, combinatorics, etc. Many important bioinformatics topics will be used as examples to illustrate how the formulation and solution of a computer science problem can help to answer a biological question.

Preliminary topics to be covered:

1. Introduction to algorithms
2. Exact string matching
3. Suffix tree: applications
4. Burrows-Wheeler Transform
5. Mismatch tree and the motif finding problem
6. Breaking problems down: dynamic programming
7. Combinatorial search: intractable problems
8. Integer programming; Reductions
9. Graph algorithms: trees
10. Haplotyping via perfect phylogeny
11. Comparing trees
12. De Bruijn graph; Eulerian graphs
13. Minimum Spanning trees; Shortest paths
14. Matching problems; Network flow
15. Breakpoint graph
16. Graph-based clustering
17. Heuristic algorithms

Student Learning Outcomes
The students will learn how to formulate computational problems and how to design efficient algorithms for some biological questions.

Enrollment Requirements
This course is designed for computer science graduate students. No biology knowledge is required. Graduate students with either biology or physical/computer science backgrounds who have taken a fundamental bioinformatics course are also welcome to take this course.
Prerequisite: COT 5405 or CAP 5510 or instructor approval.

Course Activities
The student will be expected to participate in in-class discussions, take-home assignments, exams, and in-class presentation. The student should plan on at least eight-ten hours for each homework assignment outside of class.

Important Dates
- Please note the official university holidays or closures, drop/withdrawal deadlines, exam dates, assignment deadlines, or other dates in the UCF Academic Calendar that pertain to your course.
- Midterm exam (tentative date: Week of October 11).
- Final exam – please see the university registrar's page for information regarding the final exam.
- Due dates for homework assignments would be indicated when they are assigned.

Assignment Submission
- There will be 4 take-home assignments.
- Submissions are online through Webcourses@UCF before the due date/time.

Assessment and Grading Procedures
Assignments (40%), Midterm exam (20%), Final exam (20%), Algorithm Presentation (15%), Attendance and Participation (5%).

Final Score	Letter Grade
90 or above	A
85 - 89.99	A-
80 - 84.99	B+
75-79.99	B
65-74.99	C
Below 65	D

Note: plus/minus grades will be issued, when deemed appropriate. The instructor reserves the right to change the grading policy at any time, but will not make the requirements more stringent than those stated here.

Guideline for Problem Solving Assignments
Most problems will be algorithm design problems, where you are given a computational problem and asked to design and analyze an efficient algorithm for the problem. Any solution to an algorithm design question should contain the following four sections:
1. **Problem statement.** A clear unambiguous statement of the problem to be solved.
2. **Algorithm description.** A clear, unambiguous description of the algorithm. This can be in (well-documented, clear) pseudo-code (with explanations in English) or in (precise, mathematical, well-defined) English. There should be no room for interpretation in the steps carried out by your algorithm. Any mathematically and computer literate individual should be able to follow the steps presented, or to implement the algorithm as a computer program. Such implementations by different people should still be essentially identical.
3. **Correctness proof.** A convincing mathematical argument that the algorithm described solves the computational problem described. Sometimes this can be brief, but it must always be given.
4. **Time analysis.** A time analysis of the algorithm, up to order, in terms of all relevant parameters. You must prove this analysis is correct. Frequently, this will be brief, but occasionally the time analysis will be the heart of the question, and can be quite challenging.

All assignments are to be your own work. If you see solutions to the homework problems, you should write up the final solution without consulting the text and should give an acknowledgement of the text on the first page of your solutions. Please be sure follow the following guidelines:

1. You are allowed to verbally discuss the homework assignment problems to the extent of formulating your ideas as a group. However you must write up the solutions to each problem set completely on your own. You must also list the names of everyone whom you discussed the problem set with on the first page of your homework.
2. Do not share any written solutions or partial solutions with other students.
3. **Acknowledge all the supplementary texts and other resources that you have consulted, and anyone who helped with assignments, except the instructor.**
4. **Do not discuss the exams with anyone except the instructor. You can look for answers to the exam problems on the Internet. But, please make sure acknowledge that.**

Standard of Grading

Your answer will be graded on the following criteria:

1. Your algorithm must be clearly and unambiguously described.
2. You need to prove your algorithm correctly solves the problem. If a proof of correctness is missing, I will assume that your algorithm is incorrect and grade accordingly. I will use this rule in grading even if I know your algorithm is correct. In some cases, correctness is easy or trivial; in this case, your correctness argument can be a short English explanation. Other times, correctness is highly non-trivial and requires a medium-sized mathematical argument. It is your job to distinguish these two cases.
3. Your time analysis must be proved correct. A time analysis is usually an upper bound on worst-case time. At a minimum, a time analysis requires an explanation of where the calculations come from. If the analysis is "easy" (e.g., with a simple nested loop algorithm), these explanations can be brief (e.g., "The outside loop goes from 1 to n, and each iteration, the inside loop iterates m times, so the overall time is O(nm)."). Other times, the time analysis is a tricky, mathematical proof.
4. Your algorithm must be efficient. Although we sometimes use "polynomial time" as a benchmark for "efficient", this isn't a hard and fast rule. An algorithm is efficient for a problem if there is no competing algorithm that is much faster.
5. For the bonus implementation project, you should present an outline of the basic algorithm you used, a discussion of implementation problems, and time/space information for various input instances. Provide the programming language. Your grade will be based on your answer's completeness, and your success and time for challenge problems.
6. All assignments/projects must be **typed** in LaTex (you can draw figures or diagrams by hand).

Make-up Exams and Assignments

Per university policy, students are be allowed to turn in make-up work (or an equivalent, alternate assignment) for university-sponsored events, religious observances, or legal obligations (such as jury duty). In these instances, students are also be excused from class without penalty. Otherwise, late homework and make-up work will not be accepted. Homework assignments should be turned in before/at the beginning of the class at the specific due dates.

No makeup exams will be given, unless arrangements have been made with the instructor at least one week prior to the exam date, with authorized and verifiable documentation.

Extra Credit

There will be some bonus problems and/or bonus implementation projects for extra credit.

Attendance/Participation

Class attendance is expected. You are encouraged to ask questions in class. Five points of your grades out of 100 required grades are based on your attendance and participation. And, it is your responsibility to stay abreast of the material presented in class.

Grade Dissemination
To ensure students have prompt feedback, and knowledge of their progress, course grades will be recorded in Webcourses@UCF and follow student data classification and security standards.

Grades for the assignments and the midterm-exam will not be challenged one week after the grade release day. If you do not see your grades, please contact the instructor.

Course Materials and Resources
No required textbooks.

Optional References:

- P.A. Pevzner, Computational Molecular Biology: An Algorithmic Approach. The MIT Press, 2000 (CMB)
- D. Gusfield. Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology. Cambridge University Press, 1997 (Dan)
- Phillip Compeau and Pavel Pevzner, Bioinformatics Algorithms: An Active Learning Approach, Volume 1 and Volume 2. Active Learning Publishers, 2015 (BA)

Policy Statements

Financial Aid Requirement
All faculty are required to document students' academic activity at the beginning of each course. This academic activity must be completed by the end of the first week of classes or as soon as possible after adding the course. Failure to do so may result in a delay in the disbursement of your financial aid. Instructions on how to complete this academic activity will be given in class.

Course Accessibility and Disability COVID-19 Supplemental Statement
Accommodations may need to be added or adjusted should this course shift from an on-campus to a remote format. Students with disabilities should speak with their instructor and should contact sas@ucf.edu to discuss specific accommodations for this or other courses.

Academic Integrity
Students should familiarize themselves with UCF's Rules of Conduct at <https://scai.sdes.ucf.edu/student-rules-of-conduct/>. According to Section 1, "Academic Misconduct," students are prohibited from engaging in

1. Unauthorized assistance: Using or attempting to use unauthorized materials, information or study aids in any academic exercise unless specifically authorized by the instructor of record. The unauthorized possession of examination or course-related material also constitutes cheating.
2. Communication to another through written, visual, electronic, or oral means: The presentation of material which has not been studied or learned, but rather was obtained through someone else's efforts and used as part of an examination, course assignment, or project.
3. Commercial Use of Academic Material: Selling of course material to another person, student, and/or uploading course material to a third-party vendor without authorization or without the express written permission of the university and the instructor. Course materials include but are not limited to class notes, Instructor's PowerPoints, course syllabi, tests, quizzes, labs, instruction sheets, homework, study guides, handouts, etc.
4. Falsifying or misrepresenting the student's own academic work.
5. Plagiarism: Using or appropriating another's work without any indication of the source, thereby attempting to convey the impression that such work is the student's own.
6. Multiple Submissions: Submitting the same academic work for credit more than once without the express written permission of the instructor.
7. Helping another violate academic behavior standards.
8. Soliciting assistance with academic coursework and/or degree requirements.

Responses to Academic Dishonesty, Plagiarism, or Cheating
Students should also familiarize themselves with the procedures for academic misconduct in UCF's student handbook, *The Golden Rule* <https://goldenrule.sdes.ucf.edu/>. UCF faculty members have a responsibility for students' education and the value of a UCF degree, and so seek to prevent unethical behavior and respond to academic misconduct when necessary. Penalties for violating rules, policies, and instructions within this course can range from a zero on the exercise to an "F" letter grade in the course. In addition, an Academic Misconduct report could be filed with the Office of Student Conduct, which could lead to disciplinary warning, disciplinary probation, or deferred suspension or separation from the University through suspension, dismissal, or expulsion with the addition of a "Z" designation on one's transcript.

Being found in violation of academic conduct standards could result in a student having to disclose such behavior on a graduate school application, being removed from a leadership position within a student organization, the recipient of scholarships, participation in University activities such as study abroad, internships, etc.

Let's avoid all of this by demonstrating values of honesty, trust, and integrity. No grade is worth compromising your integrity and moving your moral compass. Stay true to doing the right thing: take the zero, not a shortcut.

Unauthorized Use of Websites and Internet Resources
There are many websites claiming to offer study aids to students, but in using such websites, students could find themselves in violation of academic conduct guidelines. These websites include (but are not limited to) Quizlet, Course Hero, Chegg Study, and Clutch Prep. UCF does not endorse the use of these products in an unethical manner, which could lead to a violation of our University's Rules of Conduct. They encourage students to upload course materials, such as test questions, individual assignments, and examples of graded material. Such materials are the intellectual property of instructors, the university, or publishers and may not be distributed without prior authorization. Students who engage in such activity could be found in violation of academic conduct standards and could face course and/or University penalties. Please let me know if you are uncertain about the use of a website so I can determine its legitimacy.

Unauthorized Distribution of Class Notes
Third parties may attempt to connect with you to sell your notes and other course information from this class. Distributing course materials to a third party without my authorization is a violation of our University's Rules of Conduct. Please be aware that such class materials that may have already been given to such third parties may contain errors, which could affect your performance or grade. Recommendations for success in this course include coming to class on a routine basis, visiting me during my office hours, connecting with the Teaching Assistant (TA), and making use of the Student Academic Resource Center (SARC), the University Writing Center (UWC), the Math Lab, etc. If a third party should contact you regarding such an offer, I would appreciate your bringing this to my attention. We all play a part in creating a course climate of integrity.

In-Class Recording
Students may, without prior notice, record video or audio of a class lecture for a class in which the student is enrolled for their own personal educational use. A class lecture is defined as a formal or methodical oral presentation as part of a university course intended to present information or teach enrolled students about a particular subject. Recording class activities other than class lectures, including but not limited to lab sessions, student presentations (whether individually or part of a group), class discussion (except when incidental to and incorporated within a class lecture), clinical presentations such as patient history, academic exercises involving student participation, test or examination administrations, field trips, private conversations between students in the class or between a student and the faculty member, and invited guest speakers is prohibited. Recordings may not be used as a substitute for class participation and class attendance, and may not be published or shared without the written consent of the faculty member.

Failure to adhere to these requirements may constitute a violation of the University's Student Code of Conduct as described in the Golden Rule.

Course Accessibility Statement
The University of Central Florida is committed to providing access and inclusion for all persons with disabilities. Students with disabilities who need access to course content due to course design limitations should contact the professor as soon as possible. Students should also connect with Student Accessibility Services (SAS) <http://sas.sdes.ucf.edu/> (Ferrell Commons 185, sas@ucf.edu, phone 407-823-2371). For students connected with SAS, a Course Accessibility Letter may be created and sent to professors, which informs faculty of potential course access and accommodations that might be necessary and reasonable. Determining reasonable access and accommodations requires consideration of the course design, course learning objectives and the individual academic and course barriers experienced by the student. Further conversation with SAS, faculty and the student may be warranted to ensure an accessible course experience.

Campus Safety Statement
Emergencies on campus are rare, but if one should arise during class, everyone needs to work together. Students should be aware of their surroundings and familiar with some basic safety and security concepts.

- In case of an emergency, dial 911 for assistance.
- Every UCF classroom contains an emergency procedure guide posted on a wall near the door. Students should make a note of the guide's physical location and review the online version at <https://centralflorida-prod.modolabs.net/student/safety/index>.
- Students should know the evacuation routes from each of their classrooms and have a plan for finding safety in case of an emergency.
- If there is a medical emergency during class, students may need to access a first-aid kit or AED (Automated External Defibrillator). To learn where those are located, see <https://ehs.ucf.edu/automated-external-defibrillator-aed-locations>.
- To stay informed about emergency situations, students can sign up to receive UCF text alerts by going to <https://my.ucf.edu> and logging in. Click on "Student Self Service" located on the left side of the screen in the toolbar, scroll down to the blue "Personal Information" heading on the Student Center screen, click on "UCF Alert", fill out the information, including e-mail address, cell phone number, and cell phone provider, click "Apply" to save the changes, and then click "OK."
- Students with special needs related to emergency situations should speak with their instructors outside of class.
- To learn about how to manage an active-shooter situation on campus or elsewhere, consider viewing this video (<https://youtu.be/NIKYajEx4pk>).

Deployed Active Duty Military Students
If you are a deployed active duty military student and feel that you may need a special accommodation due to that unique status, please contact your instructor to discuss your circumstances.

***Modifications may be made to the syllabus and students will be duly notified of any such changes.