



Advanced Topics in Bioinformatics and Computational Biology; Algorithms, AI, and Hardware for Biological Data (CMSC829C)

Term: Fall 2026

Professor: Can Firtina

Email: firtina@umd.edu

Office Hours: TuTh 4:45pm - 5:30pm (IRB 3236)

Credits: 3

Course Dates: From Sep 1, 2026 - Dec 10, 2026

Course Times: TuTh 3:30pm - 4:45pm

Classroom: IRB 2107

Course Description

Computational methods and hardware systems play an increasingly central role in biological research, making it possible to analyze the large, complex datasets produced by modern high-throughput experiments on DNA, RNA, and proteins. Analyzing this data quickly, accurately, and energy-efficiently is critical for time-sensitive clinical decisions, for understanding disease mechanisms, and for extracting meaningful insight from noisy, massive datasets.

This seminar covers cutting-edge and foundational research on **algorithms, machine learning (ML), and hardware accelerators for bioinformatics**. We will select papers from genomics, transcriptomics, proteomics, biological language models, and emerging computing paradigms. You will read and analyze relevant papers, learn how to design and evaluate computational methods for biological data, and explore how *co-designing* algorithms with the perspective of the underlying hardware (e.g., GPUs, FPGAs, and processing-in-memory technologies) unlocks new capabilities.

One of the main goals of this course is to provide you with the necessary skills for reading, analyzing, presenting, and reviewing research strongly. We use a structured, widely-adopted way to read, analyze, and present a paper, and you will practice it throughout the semester. That same structure will enable you to present your work with exceptional clarity, read and analyze papers more critically, and, building directly on those analysis skills, write high-quality paper reviews. These abilities carry over to any research area and to other parts of computer science. **No prior background in biology is required**, and we build the fundamental concepts as we go.

The course is intended primarily for **graduate students**; advanced undergraduates with a strong research interest are welcome. Students who have taken **CMSC423 (Computational Genomics)** may find this seminar a natural next step into current research, though it is not a prerequisite. If you are curious about how computation meets biology and want to sharpen your ability to read, present, analyze, and review research, this course will provide the necessary fundamental building blocks.

Learning Outcomes

After successfully completing this course you will be able to:

- **Read and analyze** a research paper with a structured, widely-used method by identifying the key research problem that a paper tackles, key ideas, results, and insights, as well as the paper's strengths and weaknesses.
- **Present a paper with exceptional clarity** using that same structure (the problem and why it matters, the key ideas, the mechanisms, the results, the strengths and weaknesses, and the open questions), and lead a substantive discussion.
- **Write a strong, constructive paper review** by applying the same structured reading and analysis you practice all semester.
- **Explain and compare** the algorithmic, machine learning, and hardware approaches to biological data analysis, including algorithm-architecture co-design trade-offs in accuracy, speed, memory, energy, and portability.
- **Gain** an interdisciplinary perspective that collectively spans algorithms, machine learning, and hardware approaches to solve fundamental challenges in bioinformatics.

Required Resources

- **Course Website:** <https://storm.cs.umd.edu/teaching/cmsc829c/>. Slides and materials are posted publicly.
- **Readings:** There is no required textbook. Each session's reading is an assigned research paper, provided through the course website. Optional background references may be suggested for context.
- **ELMS-Canvas:** announcements, discussion-question submissions, assignment submission, and grades.

Course Structure

This course meets twice a week for 75 minutes and unfolds in two phases.

Lectures (first ~5 weeks):

The instructor provides lectures introducing biological data analysis and the common algorithmic, machine learning, and hardware approaches used across applications, together with explicit instruction on how to read, review, analyze, and extremely clearly present a research paper. These sessions provide the fundamentals on the topics we will cover for the rest of the term. *(Depending on enrollment, the number of lectures may be adjusted.)*

Paper presentations (remainder of the term):

Each session covers **one research paper, led by a student**. We will release a list of papers spanning algorithms, machine learning, and hardware accelerators for bioinformatics. Students will choose from this list based on their interests. With one paper per session, each student typically leads one session (this may flex with enrollment). We try to schedule related papers in consecutive sessions.

How a presentation works:

- **Prepare with a mentor.** Before you present, you must meet at least once with your mentor (the instructor and/or TA), at least one week in advance, bringing a draft of your slides. Acting on this feedback is part of your grade. It is best to schedule this meeting early as last-minute meetings leave no time for follow-up. These meetings are quite useful in understanding the ways to deliver clear talks, which is quite useful for research and for building effective scientific communication skills.

- **Follow the talk structure.** Use the structure of a good paper talk: (0) title, authors, and venue; (1) the problem, its context, and why it matters (real-world or biomedical relevance); (2) the key ideas and insight; (3) the mechanisms, or how it works; (4) the key results; (5) the strengths; (6) the weaknesses; (7) your own ideas on how it could be improved; (8) the takeaways and questions to start the discussion.
- **Lead the discussion.** In a 75-minute session, plan for about 40 minutes to present and analyze the paper and about 30 minutes to lead the discussion. Submit your final slides at least 24 hours before class.

Reading and discussion:

For each presentation session you are not leading, read the paper in advance and submit discussion questions the night before. Come ready to take part. Your questions and engagement are important for a lively discussion.

Paper review (end of term):

Late in the semester you will write a structured peer review of a paper, following the way real conference or journal reviews are written. By then you will have spent the term reading and analyzing papers with the same structured method, which is what strong reviewing builds on, so the review draws directly on the skills you have been practicing. We discuss the reviews together in the final session.

Tips for Success in this Course

- **Participate.** Ask questions and discuss the material with your classmates. You learn a lot by exchanging ideas with your peers, the instructor, and the TA, and it sharpens your own thinking.
- **Prepare well in advance.** Email your mentor early to set up your feedback meeting, and read each session's paper early enough to write thoughtful questions. Last-minute preparation tends to produce weaker questions and weaker talks.
- **Check the course resources regularly.** Log in to ELMS-Canvas and the course website several times a week (more when deadlines are near) and turn on notifications so you do not miss announcements or changes to due dates.
- **Communicate.** If you are stuck on a concept or a logistics issue, please reach out to the instructor (firtina@umd.edu), the TA, or your classmates.

Grading

Your grade is based on four components.

Leading paper presentations (35%)

- **Before-class preparedness (10%).** You contacted your mentor at least one week before your session, brought a draft of your slides, and addressed the feedback you received.
- **Presentation (15%).** The clarity, structure, and content of your talk; how well you understand the paper, including how you frame the biological problem, the data and benchmarks, and the method's assumptions and limitations; your delivery; and how well you answer questions. In grading, we take into account the difficulty of the paper, the time you had to prepare, and how well you addressed your mentor's feedback.
- **Analysis and discussion leadership (10%).** The depth and quality of your analysis (strengths, weaknesses, and your own ideas) and how well you lead the discussion.

Participation (20%)

We look at how actively and constructively you take part in the sessions you are *not* leading: engaging with the presenter and your peers, building on what others say, and helping drive the discussion (often from the questions submitted beforehand).

Submitting discussion questions (25%) *(due 11:59 PM the day before each presentation session)*

Before each session you are not leading, read the assigned paper and submit thoughtful questions that can spark discussion. The presenter may share some of them during the discussion. Questions are graded on quality and on evidence of critical thinking; generic questions (e.g., "What if you ran it on dataset X?") are generally discouraged. To allow for busy weeks and the occasional absence, your five lowest discussion-question scores (including any sessions you could not attend) are dropped.

Paper review (20%) *(due Thursday, December 10, 2026; discussed in the final session)*

You will write a structured paper review of an assigned paper, following the way real conference/journal reviews are written (a summary; strengths; weaknesses; concrete suggestions; and an overall assessment). We provide detailed instructions and the components to include. Your review is graded on content, clarity, and the quality of your analysis, and you will get feedback to help you improve your reviewing skills. We discuss the reviews together in the last class.

Final Grades

Late work is **not** accepted for course credit, so plan to submit well before each deadline. Any formal grade dispute must be submitted in writing within one week of receiving the grade.

Final letter grades use plus/minus grading and are based on the percentage of total points earned:

Final Grade Cutoffs									
A+	97.00%	B+	83.00%	C+	73.00%	D+	63.00%	F+	
A	90.00%	B	80.00%	C	70.00%	D	60.00%	F	<56.00%
A-	86.00%	B-	76.00%	C-	66.00%	D-	56.00%	F-	

Note for graduate students: a grade below **C-** earns no graduate degree credit (UMD Graduate School policy). Being close to a cutoff is not the same as reaching it (e.g., 89.99% does not round up to 90.00%), so the cutoffs are applied consistently to be fair to everyone. All scores are posted on ELMS-Canvas; to review any grade, email the instructor to set up a time.

Tentative Schedule

This is a tentative schedule and may change. Check the course website and ELMS-Canvas for current deadlines and the latest schedule. If there is a prolonged university closing or an extended absence, we will adjust the schedule, deadlines, and assignments based on the dates missed.

Week #	Day	Lecture/Session
1	09/01/2026	Introduction and Course Logistics
1	09/03/2026	How to Read, Review, and Present a Research Paper
2	09/08/2026	Introduction to Biological Data Analysis
2	09/10/2026	Genomics I
3	09/15/2026	Genomics II
3	09/17/2026	Transcriptomics
4	09/22/2026	Proteomics
4	09/24/2026	Hardware Accelerators for Bioinformatics I
5	09/29/2026	Hardware Accelerators for Bioinformatics II
5	10/01/2026	Hardware Accelerators for Bioinformatics III
6	10/06/2026	Paper Presentation Session #1
6	10/08/2026	Paper Presentation Session #2
7	10/13/2026	No class (Fall Break, Oct 12-13)
7	10/15/2026	Paper Presentation Session #3
8	10/20/2026	Paper Presentation Session #4
8	10/22/2026	Paper Presentation Session #5
9	10/27/2026	Paper Presentation Session #6
9	10/29/2026	Paper Presentation Session #7
10	11/03/2026	Paper Presentation Session #8
10	11/05/2026	Paper Presentation Session #9
11	11/10/2026	Paper Presentation Session #10
11	11/12/2026	Paper Presentation Session #11
12	11/17/2026	Paper Presentation Session #12
12	11/19/2026	Paper Presentation Session #13
13	11/24/2026	Paper Presentation Session #14
13	11/26/2026	No class (Thanksgiving Recess, Nov 25-29)
14	12/01/2026	Paper Presentation Session #15
14	12/03/2026	Paper Presentation Session #16
15	12/08/2026	Paper Presentation Session (Buffer)
15	12/10/2026	Paper Review Discussion Session

Calendar dates follow the published UMD Fall 2026 academic calendar (Provost's Office) and will be confirmed before the semester begins. With one paper per session, the 16 presentation slots fit up to 16 presenters, and Tuesday 12/08 is held as a buffer for catch-up or overflow. If enrollment runs higher, the buffer can host an extra presentation, a session can hold two short presentations, or a lecture can become a presentation slot.

Generative AI Policy

You are responsible for everything you submit under your name. Generative AI tools (TerpAI, ChatGPT, Gemini, Claude, and the like) can help you learn, but they cannot replace the reading, analysis, and communication skills this course is meant to build. Following [UMD's Guidelines for the Use of Generative AI](#), you must **disclose and cite** any *substantive* use, and you are accountable for the accuracy, integrity, and originality of your work. Because these tools are available, the bar for the depth of your analysis and the quality of your presentations is set accordingly.

Where AI helps in this course, and where it does not:

Reading and understanding papers: Use AI to explain unfamiliar concepts, math, or biological background. You own the accuracy of what you take away.

Pre-class discussion questions: AI is fine for grammar and clarity polish only, not for generating the questions or their substance.

Presentation and slides: Slide design, redrawing figures, and language polish are fine. Your critique, analysis, and ideas must be your own.

Paper review: Not allowed beyond spell-check and grammar. Reviewing a paper is the core skill being assessed.

Code and scripts (if any): Useful for understanding or implementing methods. You must verify correctness yourself.

When you use AI in a meaningful way on a deliverable, add a short note (e.g., "AI acknowledgment: I used [tool] to [do what]"). Cite AI tools following [UMD Libraries' guidance](#).

If an activity is not listed above, assume AI is not allowed unless you ask first. Undisclosed or unauthorized use is treated as unauthorized assistance under the UMD Code of Academic Integrity and the GenAI Guidelines.

I am glad to approve reasonable uses.

Academic Integrity

Academic dishonesty includes cheating, fabrication, and plagiarism, and also helping others do the same (e.g., by sharing your work). In short, all submitted work must be your own. Cases of academic dishonesty are handled to the fullest extent set by the [Office of Student Conduct](#). The typical sanction for a student found responsible is the grade "XF," which marks a failure due to academic dishonesty. If you are unsure whether something would count as academic dishonesty, ask the instructor before you act.

The CS Department takes academic integrity seriously; see the department's [Academic Integrity](#) page. Some assignments may be collected through Turnitin on ELMS, and you will be told if that is the case.

Course-assistance websites and AI-generated content are not allowed sources unless the instructor permits them. See the **Generative AI Policy** above for exactly when and how AI tools may be used in this course. Collaboration on graded work is not allowed unless stated otherwise; ordinary discussion of course concepts with classmates is fine and encouraged (e.g., when preparing your discussion questions). If you are ever unsure about what level of collaboration is acceptable, please ask.

Course Guidelines

Names and Pronouns:

If you wish, let me know the name and the pronouns you would like me to use for you. I will do my best to use them, and I ask everyone in class to do the same.

Video or Audio Recording:

Video or audio recording of class sessions, activities, or discussions is prohibited without advance permission from the professor. Maryland is one of 11 U.S. states that require two-party, or all-party, consent before it is permissible to record or otherwise intercept and/or capture communications (such as phone calls, in-person conversations, video conferences). This means that everyone participating in a conversation must give their consent before any communication is recorded. Read this UMD article on [Audiovisual Recording](#) for more information.

Communication with Instructor:

Email me at firtina@umd.edu. Please do not email about things that are easy to find in the syllabus or on ELMS (such as due dates), but please do reach out about academic, intellectual, or personal concerns. I aim to reply within 24 hours on weekdays. I send important announcements through ELMS, so please turn on email and announcement notifications so you do not miss changes to assignments or due dates.

Communication with Peers:

We will sometimes disagree or debate, and that is fine. Please be professional and help keep a classroom where we can discuss hard questions with respect. Free expression is welcome, and it comes with the responsibility to argue in good faith. This is not a space for hate speech, harassment, or derogatory language. Tell me right away if you ever feel threatened, dismissed, or silenced.

Policies and Resources

It is our shared responsibility to know and follow the University of Maryland's course-related policies, which cover academic integrity, student and instructor conduct, accessibility and accommodations, attendance and excused absences, grades and appeals, and copyright and intellectual property. Please reference and review the [Office of Undergraduate Studies' Course-Related Policies](#) and [Graduate School's Course Related Policies](#), and follow up with me if you have questions.

Accessibility and Disability Services

The University of Maryland is committed to creating and maintaining a welcoming and inclusive educational, working, and living environment for people of all abilities. The University of Maryland is also committed to the principle that no qualified individual with a disability shall, on the basis of disability, be excluded from participation in or be denied the benefits of the services, programs, or activities of the University, or be subjected to discrimination. The [Accessibility & Disability Service \(ADS\)](#) provides reasonable accommodations to qualified individuals to provide equal access to services, programs and activities. ADS cannot assist retroactively, so it is generally best to request accommodations several weeks before the semester begins or as soon as a disability becomes known. Any student who needs accommodations should contact me as soon as possible so that I have sufficient time to make arrangements.

For assistance in obtaining an accommodation, contact Accessibility and Disability Service at 301-314-7682, or email them at adsfrontdesk@umd.edu.

Emergency Preparedness

Emergencies on campus can happen at any time. To prepare, visit prepare.umd.edu or use the emergency symbol in the UMD App to review information. Resources for persons with disabilities are available on the [emergency preparedness page of the ADA Coordinator's website](#).

Student Resources and Services

Taking personal responsibility for your own learning means acknowledging when your performance does not match your goals and doing something about it. I hope you will come talk to me so that I can help you find the right approach to success in this course, and I encourage you to visit [UMD's Student Academic Support Services website](#) to learn more about the wide range of campus resources available to you.

In particular, everyone can use some help sharpening their communication skills (and improving their grade) by visiting [UMD's Writing Center](#) and schedule an appointment with the campus Writing Center.

You should also know there are a wide range of resources to support you with whatever you might need ([UMD's Student Resources and Services website](#) may help). If you feel it would be helpful to have someone to talk to, visit [UMD's Counseling Center](#).

Basic Needs Security

If you have difficulty affording groceries or accessing sufficient food to eat every day, or lack a safe and stable place to live, please visit [UMD's Division of Student Affairs website](#) for information about resources the campus offers you and let me know if I can help in any way.

Veteran Resources

UMD provides some additional support to our student veterans. You can access those resources at the office of [Veteran Student life](#) and the [Counseling Center](#). Veterans and active duty military personnel with special circumstances (e.g., upcoming deployments, drill requirements, disabilities) are welcome and encouraged to communicate these, in advance if possible, to the instructor.

Notice of Mandatory Reporting

Notice of mandatory reporting of sexual assault, sexual harassment, interpersonal violence, and stalking: As a faculty member, I am designated as a "Responsible University Employee," and I must report all disclosures of sexual assault, sexual harassment, interpersonal violence, and stalking to UMD's Title IX Coordinator per University Policy on Sexual Harassment and Other Sexual Misconduct.

If you wish to speak with someone confidentially, please contact one of UMD's confidential resources, such as [CARE to Stop Violence](#) (located on the Ground Floor of the Health Center) at 301-741-3442 or the [Counseling Center](#) (located at the Shoemaker Building) at 301-314-7651.

You may also seek assistance or supportive measures from UMD's Title IX Coordinator by calling 301-405-1142, or emailing titleIXcoordinator@umd.edu.

To view further information on the above, please visit the [Office of Civil Rights and Sexual Misconduct](#).

Course Evaluation

Please submit a course evaluation through Student Feedback on Course Experiences in order to help faculty and administrators improve teaching and learning at Maryland. All information submitted to Course Experiences is confidential. Campus will notify you when Student Feedback on Course Experiences is open for you to complete your evaluations at the end of the semester. Please go directly to the [Student Feedback on Course Experiences](#) to complete your evaluations. You may access the evaluation reports for courses for which 70% or more students submitted their evaluations.

Copyright Notice

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This syllabus and schedule are tentative and may change; the course website and ELMS-Canvas have the most current information.