Syllabus

CSCI 295: AI in the Scientific Loop

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CSCI 295 AI in the Scientific Loop **1**

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CSCI 295 AI in the Scientific Loop

Hope College - Spring 2027

> **Note**
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> **Draft, September 2026.** The week-by-week schedule is still being planned, and some details may change before the semester begins.

Course Information

Section	Time	Instructor	Room	Final exam period
Monday/Wednesday	8:00–9:20 a.m.	Brian Yurk	TBA	Wed May 5, 3:00–5:00 p.m. (to be confirmed)
Tuesday/Thursday	1:30–2:50 p.m.	Catie Welsh	TBA	Fri May 7, 12:30–2:30 p.m.

Section days and times are planned but not final. Rooms have not been assigned.

Instructor	Email	Office	Office Hours
Brian Yurk	yurk@hope.edu	VWF 215	TBD, or by appointment
Catie Welsh	welshc34@hope.edu	VWF 229	TBD, or by appointment

Credit Hours	3
Prerequisites	None. No programming or prior AI experience is expected.
Course Site	This site (schedule, activities, readings, policies) and Moodle (grades, submissions).

Course Description

Generative AI is rapidly changing how scientists find information, analyze data, write, code, communicate, and solve problems. This course prepares students to use these tools effectively and thoughtfully in their academic work and future careers. Students will develop a practical understanding of what generative AI is, how tools such as large language models work, and what they can and cannot reliably do. Students will learn to evaluate AI-generated information, recognize limitations and potential sources of error, and make informed decisions about when and how AI should be used. The course will also examine broader questions surrounding reliability, bias, privacy, ethics, scientific integrity, and the changing role of human expertise in an AI-enabled world. Students will explore applications of generative AI within their own scientific disciplines and complete a project using AI to address a problem or task relevant to their field. No prior programming or AI experience is required.

Course Learning Outcomes

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

1. **Explain how generative AI works and where its limitations come from.** Develop a practical understanding of large language models and related AI systems sufficient to reason about their capabilities, limitations, and behavior.

2. **Evaluate AI outputs critically and use AI responsibly.** Assess the reliability of AI-generated information and recognize issues involving error, bias, privacy, ethics, scientific integrity, and appropriate human oversight.
3. **Use generative AI effectively as part of scientific work.** Apply AI tools to tasks such as finding and understanding information, analyzing data, writing and interpreting code, communicating scientific ideas, and solving problems.
4. **Make informed decisions about AI's role in scientific practice.** Evaluate when AI adds value, when it should not be used, and where human expertise and judgment remain essential.

Instruction

The course develops through three overlapping phases:

- Foundations: Python and responsible AI use. We begin with computational thinking and introductory Python while establishing expectations for ethical, transparent, and thoughtful use of generative AI. During early programming work, AI may be used as a tutor for questions and explanations but not simply to write the code for you.
- Understanding how AI works. We build enough foundation in machine learning and neural networks to understand the ideas that lead to transformers and modern generative AI. We then examine how large language models are trained, why they behave as they do, how programs interact with them through APIs, and how models can be combined with tools to create agents. Labs allow you to experiment with these systems and investigate their capabilities and limitations rather than encountering the ideas only in lecture.
- Application and scientific practice. The emphasis shifts toward using AI within scientific workflows, student-led discussions about AI in scientific fields, and collaborative work on the final project.

Most class meetings will mix short lecture or demonstration with hands-on work. Early in the semester, labs will occur frequently; later, they will generally occur about once per week as more class time shifts toward discussion, application assignments, and project work. Many labs will begin with roughly an hour of in-class work and be completed outside class, including reflection or what-if questions designed to check that you understand the code, model, or analysis.

Discernment in This Course

The guiding principle of this course is that AI can participate in the scientific loop, but humans remain responsible for the scientific reasoning. Effective AI use is therefore not simply a matter of writing better prompts. You must decide what a good result looks like, what evidence is needed, what should be delegated, what should remain under human control, and how much verification a result deserves.

Discernment runs throughout the course:

- **Discussion and writing.** Early in the semester we will establish expectations for ethical and responsible AI use. Later discussions will increasingly be led by student groups and will examine the implications of AI for scientific disciplines, scientific integrity, expertise, bias, privacy, and the future of scientific work.
- **Labs and model investigations.** What-if questions and code-analysis prompts will ask you to explain what code or a model is doing, predict how changes should affect results, and evaluate whether an output makes scientific sense.
- **AI-assisted programming and analysis.** When AI begins writing more of the code, your responsibility shifts toward understanding, testing, documenting, and defending the analysis rather than simply getting code to run.
- **Projects.** Both the midterm data-analysis project and final project require you to justify analytical choices and explain the role AI played in the workflow.

Materials and Technology

- No textbook. Readings, videos, and podcasts are linked from the course site. Because this field changes quickly, some materials may be updated during the semester.
- A fairly recent Mac or Windows laptop that you can install software on (iPads or Android tablets, Chromebooks, etc. are not sufficient/supported) for working on assignments in and out of class. Linux is welcome, but self-supported. If you do not have a laptop available to you, one will be provided by the Computer Science Department.
- Software necessary for the course installed on your laptop. This includes VS Code with various extensions, Python development tools, various Python packages, Gemini CLI, etc. You do not need to set this up before the class starts.
- An API key for using Gemini models. You do not need to set this up before the class starts.
- GitHub account for accepting and submitting assignments, developing and maintaining code repositories.
- A public website (GitHub Pages) "portfolio piece" that summarizes/demonstrates your final project. You do not need to set this up before the class starts, and there is no hosting cost.

Use of other generative AI tools. We will primarily use Google/Gemini generative AI tools. You are encouraged to responsibly explore other free and paid generative AI tools (e.g., Claude Code, Codex, Anthropic or OpenAI API, Cursor, etc.) when it is appropriate in the course. However, your instructor will not typically provide technical support for these tools.

Course Components

- **Understanding sessions.** Short lectures and demonstrations build a practical understanding of generative AI, beginning with foundational ideas about learning from data and neural networks before focusing on transformers, large language models, model training and behavior, APIs, and agents.

- **Writing and discussion.** You will examine how AI is currently being used in scientific fields and consider longer-term consequences for disciplines such as health care, mathematics, computer science, biology, and chemistry. Some later discussions will be planned and led by student groups.
- **AI in your field.** You will investigate how AI is being used in a scientific field relevant to you. This may include interviewing a faculty member or another person working in the field and connecting current practice to possible future changes.
- **Programming and model labs.** Early labs introduce Python, computational thinking, and scientific data analysis using packages such as pandas and NumPy without relying on AI to generate solutions. A short sequence then uses simple machine-learning and neural-network models to build the foundational ideas needed to understand transformers and generative AI. Later labs focus increasingly on generative AI itself, including model behavior, API calls, agents, and AI-assisted scientific analysis. Throughout the course, reflection and what-if questions ask you to explain what the code or AI system is doing and evaluate whether its output makes scientific sense.
- **Midterm data-analysis project.** You will select from several provided scientific datasets, or propose an appropriate dataset of your own, and complete a common scientific data-analysis workflow using Python: loading, inspecting, cleaning, exploring, visualizing, analyzing, and interpreting data. The goal is to establish your own understanding of computational scientific analysis before generative AI takes on a larger role later in the course.
- **Final project.** Working in assigned groups of three, you will select a scientific dataset or problem, propose and justify an appropriate approach, use generative AI and computational tools to carry out the work, and critically evaluate the results. Your final submission will include a well-documented GitHub repository, a public-facing portfolio page summarizing the project, and an AI-use disclosure. The project culminates in a group presentation with individual Q&A during the scheduled final exam period.
- **Final presentation.** Final-project presentations will take place during the scheduled final exam period.

Evaluation

Grades will be determined as follows:

Component	Weight
Attendance, in-class participation, in-class activities	5%
Writing, discussion, and AI in my field work	10%
Programming and model labs	30%
Midterm data-analysis project	20%
Group-led discussion	5%
Final project (group proposal, deliverable, presentation; individually adjusted)	30%

Final project grades start from the group's grade and are adjusted for each member based on peer contribution ratings, the individual contribution and AI-use log, the individual portion of the presentation and Q&A, and the check-in 2 defense. A member who did not contribute to a component may receive no credit for it.

Grading Scale

Your final letter grade will be determined using the following scale:

Grade	Range	Grade	Range	Grade	Range
A	93–100%	B-	80–82%	D+	67–69%
A-	90–92%	C+	77–79%	D	63–66%
B+	87–89%	C	73–76%	D-	60–62%
B	83–86%	C-	70–72%	F	0–59%

Attendance and Participation

Attendance is very important to your success in this class and to the success of your group and is considered mandatory. Much of the work happens in class: hands-on sessions, pooled experiments, writing, and discussion cannot be made up in the same way afterward. If you must miss a class (illness, scheduled college event, family matters, etc.) you should inform me and, when it applies, your group ahead of time if at all possible.

Final Exam Date

Final project presentations take place during your section's scheduled final exam period:

Section	Final exam period
Monday/Wednesday	Wednesday, May 5, 3:00–5:00 p.m. (to be confirmed)
Tuesday/Thursday	Friday, May 7, 12:30–2:30 p.m.

Each group presents for about ten minutes followed by questions. Your group's final deliverable is due at 11:59 p.m. the day before your section's exam slot.

Special Note: Do not arrange travel without confirming the dates of your final exams/projects, as dictated by the Office of the Provost.

Schedule

Dates follow Hope's published 2026–27 academic calendar and are subject to change. The current schedule, with links to materials, is on the course site.

Wk	Mon/Wed	Tue/Thu	In class	Due
1	Mon Jan 11	Tue Jan 12	Introduction to the course, then set up your laptop	
1	Wed Jan 13	Thu Jan 14	Discussion, then first steps in Python	Read, watch, and skim for discussion 1 (before class); Finish setting up your computer (000) (before class)
2	Mon Jan 18	Tue Jan 19	A language model by hand, then GitHub and loops	Read the GitHub guide and do its one-time setup (before class); Lab 1 notebook (first_steps.ipynb) on Moodle (before class)
2	Wed Jan 20	Thu Jan 21	Discussion, then a counting language model in Python	Finish 020 (loops, conditions, and dictionaries) (before class)
3	Mon Jan 25	Tue Jan 26	Data with pandas	Lab 2 (020 and 025) on GitHub (before class)
3	Wed Jan 27	Thu Jan 28		
4	Mon Feb 1	Tue Feb 2	All twelve months of sea ice data	Lab 3 (030) on GitHub (before class)
4	Wed Feb 3	Thu Feb 4		
5	Mon Feb 8	Tue Feb 9		Lab 4 (040) on GitHub (before class)
5	Wed Feb 10	Thu Feb 11		
6	*Mon Feb 15: no class (winter recess)*	*Tue Feb 16: no class (winter recess)*		
6	Wed Feb 17	Thu Feb 18		
7	Mon Feb 22	Tue Feb 23		
7	Wed Feb 24	Thu Feb 25		
8	Mon Mar 1	Tue Mar 2		
8	Wed Mar 3	Thu Mar 4		
9	Mon Mar 8	Tue Mar 9		
9	Wed Mar 10	Thu Mar 11		

Wk	Mon/Wed	Tue/Thu	In class	Due
10	*Mon Mar 15: no class (spring recess)*	*Tue Mar 16: no class (spring recess)*		
10	*Wed Mar 17: no class (spring recess)*	*Thu Mar 18: no class (spring recess)*		
11	Mon Mar 22	Tue Mar 23		
11	Wed Mar 24	Thu Mar 25		
12	*Mon Mar 29: no class (easter monday)*	Tue Mar 30		
12	Wed Mar 31	Thu Apr 1		
13	Mon Apr 5	Tue Apr 6		
13	Wed Apr 7	Thu Apr 8		
14	Mon Apr 12	Tue Apr 13		
14	Wed Apr 14	Thu Apr 15		
15	Mon Apr 19	Tue Apr 20		
15	Wed Apr 21	Thu Apr 22		
16	Mon Apr 26	Tue Apr 27		
16	Wed Apr 28	Thu Apr 29		

Other deadlines:

- Fri Jan 15, 11:59 p.m.: GitHub username (form on Moodle)

Policies & Statements

AI Use Policy

Overall Course AI Status: 🟢 Green with limits. This course is about learning to use generative AI effectively and responsibly, so AI use will eventually be required for some course work. However, the appropriate role of AI changes throughout the semester. In early programming work, you will write and understand code yourself before increasingly using AI to generate, modify, and analyze code. Individual assignments will clearly indicate what kinds of AI use are permitted or required. Alternative assignments that avoid AI are not available when AI use is an explicit learning objective.
AI is a tool for expanding what you can do. It is not a replacement for the thinking that matters: framing the problem, deciding what counts as good, interpreting evidence, making the decision, and saying what you actually mean.

Labs, AI in My Field, and the final project — Green when indicated (permitted or required, with disclosure) 🟢

When an assignment is designated Green, you may or must use AI as directed. Every individual Green submission includes a short AI-use note: what you asked the tool to do, what you

accepted or rejected, and what you checked and how. You are responsible for every result you submit and should be able to explain any part of it without the tool.
For the final project, the group's deliverable includes one AI-use note covering the whole project, and each member also keeps an individual contribution and AI-use log, submitted with the deliverable. Every member is responsible for everything the group submits, including work another member did with AI, and should be able to explain any part of it in the Q&A.

Preparing for discussions — 🟡 Yellow

You may use AI to help you understand a reading, look up an unfamiliar term, or generate questions for discussion. You may not use it to produce the writing you do in class, and you should come to discussion having actually read, watched, or listened to the assigned material.

Individual in-class assessments and the final presentation — Red (AI not allowed) 🔴

Some in-class activities are designed to assess your own understanding and reasoning and must be completed without AI. The final presentation and individual Q&A are also completed without AI. Using AI on a red-light component is academic dishonesty. You may use AI to prepare for the presentation—for example, to practice explanations, anticipate questions, or help draft slides—but any such use must be disclosed.

Think before you paste

Before you share anything with an AI tool, ask five questions. Is this mine to share? (Your own words and work, usually yes; someone else's work, grades, health, or finances, no.) Does it say something about me I would not want kept: my health, my money, passwords or ID numbers, where I live, private messages? Could it identify or embarrass a real person, including me? Would I be comfortable if it were kept and read later? Which account am I using, and what does it promise about what happens to what I paste? Your own information counts as much as anyone else's. We will practice this in week 1 and return to it when you design workflows and propose your project. In addition:

- Do not upload or share concept-check or check-in questions with AI tools.
- Do not use AI to evade policies (e.g., "rewrite this so it passes a detector").
- Do not treat AI as automatically correct; check it against evidence and your own understanding.
- Do not represent AI-generated work as entirely your own when it is not.

Transparency: how I use AI as instructor

I use AI tools extensively in developing this course: drafting and refining course documents and policies, organizing the course site, drafting and testing activities and question banks, preparing slides, and generating audio for narrated material. I always review and edit AI-generated content before it reaches you. I may experiment with AI assistance in giving feedback, but I am responsible for the results, and any personal data is handled in accordance with Hope College's data policies. If you are ever unsure whether a particular use of AI is appropriate, please ask.

Collaboration Policy

- **Practice activities and the field investigation** are individual unless an activity says otherwise. You may discuss approaches and compare results with classmates, and several activities pool class data on purpose, but the work you submit and the AI-use note must be your own.
- **Group-led discussions** are group work. Each member should be able to speak to the whole plan.
- **The final project** is group work in assigned groups of three. Share the work fairly, and make sure every member can explain every part; who presents which part is assigned by me, and Q&A questions go to individuals. You may discuss ideas with other groups, but the work submitted must be your group's own. Only the names of students who contributed belong on the submission. At the end, each member rates the others' contributions; those ratings and your individual log adjust your grade from the group's grade. If a group is not working, tell me early rather than at the end.
- **In-class writing** is completed individually without collaboration, except the group stage of the final concept check.

Late Work Policy

- Late work will not be accepted in this class.
- You must be present in class to receive credit for in-class writing, concept checks, and in-class activities.
- The final project deliverable is due for the whole group; a late group deliverable affects every member. Individual contribution and AI-use logs are due with it, and peer contribution ratings are due the day after.
- You must be present at your group's presentation. A member absent without an excused absence receives no credit for the presentation component; the rest of the group presents as planned, and the absent member's assigned part is redistributed.

Exceptions. Exceptions will only be made for excused absences, as defined by Hope College policies. If you believe you have a valid reason for an exception, please contact me as soon as possible to discuss your situation.

Diversity, Equity, and Inclusion Statement

It is my intention that every student has the opportunity to grow and flourish in this class. A crucial part of this is that each and every student deserves to feel safe and that they belong in the class. Each of us has a role in working toward creating an inclusive environment, even if doing so requires us to speak out and causes us discomfort sometimes.
The diversity that students bring to this course is viewed as an asset, and this course will function in a manner that respects and values that diversity, including race, ethnicity, gender

identity, sexuality, disability, age, socioeconomic status, nationality, religion, and culture. Please let me know if anything said or done by the instructor or other students in the class leads to hurt or offense. Such actions, even when unintentional, are deserving of attention. Racist and discriminatory policies and ideas present obstacles to student flourishing and do not reflect the values of this course. It is my intention that this course and its policies promote equal representation and equitable outcomes among groups. Please let me know if you have ideas for improving this course or its policies in ways that make it more effective for you or for other students or groups. I value your perspective, and I take it seriously.

Other Policies & College Resources

Accommodations

If you have questions about access or are a student needing accommodations for a disability, please connect with Disability and Accessibility Resources (DAR) if you haven't already done so. In addition, please contact me at the earliest opportunity after the semester commences to discuss any accommodations approved by DAR.

Academic Honesty and Integrity

As it seeks to fulfill its mission, the Hope College community assumes each of its members will operate with integrity and honesty, with a sense of personal responsibility, and with mutual trust and concern toward others in all facets of the life of the college. In order to apply this principle to academic life in a fair and consistent manner, the following policies have been adopted to clarify the expectations regarding conduct, and to establish a set of procedures for dealing with situations which violate these expectations.

— *Preamble, Code for Academic Integrity at Hope College.* More information: Student Handbook, Academic Integrity

Short-Term Absence Policy

Hope College recognizes that life events may unexpectedly interrupt an academic semester, including needing time away from campus. Thus, the purpose of a formal process for short-term, temporary absence is to improve the student experience so that they may continue progress in a course of study if unable to attend and participate in person while seeking treatment and/or recovering from a medical or mental health event, a family emergency/crisis, or other extraordinary circumstance. View the entire Short-Term Temporary Absence Policy.

If a situation arises (such as medical treatment or family bereavement) that requires a longer absence, please complete the short-term absence form to ensure that appropriate documentation is provided to the CARE team.

Excessive Absence Policy

Hope College encourages students to regularly attend class and allows faculty to develop their own classroom attendance policies. Attendance and participation in class are vital components of a residential college experience. View the entire Excessive Absence Policy.

The Hope Health Center does not provide medical excuses for missed classes, exams, or assignments, as medical conditions are confidential and often not verifiable. This is in alignment with the Academic Medical Excuse Policy and consistent with the recommendations of the American College Health Association. Thus, instructors cannot request documentation from the Hope Health Center.

Special Note: Only arrange holiday travel after confirming the dates of your final exams/projects, as the Office of the Provost dictates.

Student Complaint
Hope College is committed to the appropriate resolution of complaints as efficiently and effectively as possible. Providing a mechanism to hear complaints allows us to improve our services. Students are encouraged to speak directly to other Hope community members to resolve conflict and/or seek an informal resolution of the dispute directly with the other community member(s) whenever possible. Please use this Complaint form when such a resolution is impossible.

Safety and Emergency Preparedness
Students should dial 911 (the United States' primary emergency response system) from any phone if they or someone else experiences a medical or mental health emergency. Students can also contact Hope College's Campus Safety Office (616-395-7770) in any kind of emergency situation, and Campus Safety will contact the necessary emergency response service. You can learn more about specific emergency instructions on their webpage. Students can sign up for emergency text message alerts at plus.hope.edu.

Inclement Weather
Campus Safety sends emergency notification texts, including notices of weather-related closures, via the HOPE ALERT system. A decision to close campus offices and cancel classes is typically announced before 6:30 AM. More information regarding inclement weather notifications can be found on Campus Safety's webpage.

Academic Assistance Statement
The Academic Success Center (ASC) offers all students various free services (e.g., tutoring, testing strategies, time management resources). The ASC is located in Van Zoeren Hall, immediately adjacent to the Van Wylen Library second-floor entrance. To contact the ASC send an email to asc@hope.edu or call 616-395-7830.

Counseling and Psychological Services (CAPS)
Students may experience stressors that can impact both their academic experience and their personal well-being. These may include academic pressures, relationship challenges, alcohol or other drugs, financial concerns, identity development, body image, etc.
If you are experiencing similar concerns, we encourage you to seek support. Hope College Counseling and Psychological Services (CAPS) is a free and confidential resource. Call 616-395-7945, or visit the top floor of the Bultman Student Center to find the right support for you. If the source of your stressors is academic, please contact me or academic advising to find solutions together.

Disclaimer

This syllabus is subject to change. If changes occur, students will be notified in class or through an email or Moodle announcement.