

Spark 001: Scientific Inquiry with AI

Working with AI as a Co-Investigator

SPARK 001 / 001H • Fall 2026 • University of California, Merced

Course Syllabus

Spark 1 Sect. 200, Tuesdays & Thursdays, 9:30 – 11:20 a.m. • BSP 201

Spark 1H Sect. 201, Tuesdays & Thursdays, 1:30 – 3:20 p.m. • BSP 201

What this course asks of you

You will use AI in nearly every class session — not as a shortcut to answers, but as a collaborator in real investigations. You will measure the physical world with the phone in your pocket, work through the first analysis by hand, and then bring AI as a co-investigator to scale the analysis, ask questions, and help you communicate your findings. You will be graded on how you investigate and how well you check your work, not on arriving at a predetermined answer. The goal of the course is to help you develop habits of working with AI that make you a stronger learner now and a more capable professional later.

This is a new course, built around technology that changes month to month. We are all part of a living experiment, and learning to work in a fast-moving environment is part of what this course teaches. Not everything we try will work as planned, and we expect that. We ask for your patience when something goes sideways and your candor when an assignment isn't working. In return, we will work together to adjust in real-time, but you will never be penalized for this experimentation as long as you are engaged in the process.

Course at a Glance

Instructors	Brian Utter — brianutter@ucmerced.edu David Rakestraw — drakestraw@ucmerced.edu / rakestraw1@llnl.gov
Office Hours	Brian Utter: Wednesdays, 3:30 – 4:30 p.m., ACS 267 (<i>subject to change, see CatCourses for updates</i>) David Rakestraw: Tuesdays and Thursdays, 12:30 – 1:15 p.m., BSP 201 We are glad to meet at other times — just email us.
Class Meetings	SPARK 001 Tuesdays & Thursdays, 9:30 – 11:20 a.m., BSP 201 SPARK 001H Tuesdays & Thursdays, 1:30 – 3:20 p.m., BSP 201

Course Site	CatCourses — the schedule, materials, and announcements posted there are always the most current version. Our custom course website is: https://knowledgewithai.com/
Texts	No textbook required. All readings and materials are provided through CatCourses or the custom course website.
What to Bring	A smartphone and a laptop computer. Most modern smartphones have all the sensors we use — accelerometer, gyroscope, magnetometer, barometer, microphone, camera, and GPS. If you are not sure whether yours does, or if you do not have a suitable phone, tell us in the first week. Loaner smartphones will be available in class. There will also be desktop computers available in the classroom.

Course Description

Artificial intelligence is rapidly changing how scientists, engineers, and health professionals work. This course takes the position that the interesting question is not whether to use AI, but how to use it well. Rather than treating AI as a shortcut to quick answers, you will learn to partner with it as a co-investigator in authentic scientific inquiry.

Using the sensors already embedded in everyday smartphones — accelerometers, gyroscopes, microphones, cameras, and magnetometers — you will design and carry out investigations spanning physics, engineering, biology, and medicine. Every investigation begins with manual or low-tech analysis of a small slice of data, so that you build a concrete feel for what the numbers mean. Only then do you bring in AI to scale that analysis to the full dataset and to reach for more sophisticated methods.

The course emphasizes the habits that make this partnership work: asking productive questions, acquiring knowledge just in time, validating computational output, and reflecting on your own learning strategies. You will document not only what you found, but how you worked — including where AI supported your thinking and where it led you astray. The course is particularly well suited to anyone considering a STEM major and assumes no prior programming experience.

Course Learning Objectives

By the end of the semester, you should be able to do each of the following.

1. Problem Formulation

Translate an ambiguous goal into a question you can actually answer with data. Confronted with thousands of video frames or a noisy physiological signal, you will have to decide which questions

are worth asking and which analyses would be meaningful. Recognizing what information would be valuable, and how to obtain it, comes only from repeated practice on real problems.

2. Strategic Knowledge Acquisition

You will be presented with solving problems where you have little background knowledge. You will learn to obtain and integrate the background you need, at the moment you need it. You will develop efficient ways to pick up unfamiliar concepts mid-investigation, judge when deep understanding is required and when a working knowledge is enough, and check whether you have understood an explanation well enough to proceed. This just-in-time learning mirrors how professionals actually operate when entering a new domain.

3. Validation and Verification

Keep intellectual control and responsibility of work a machine performed for you. Because you will have worked through examples by hand first, you will be able to spot-check AI output, run sanity tests, and build confidence in the AI generated results. These verification habits transfer to any tool or collaborator that contributes to your findings.

4. Critical Interpretation

Supply the meaning that computation cannot. AI can run a Fourier transform in seconds; deciding what that result reveals about a robot's motion or human health, requires domain understanding you build through the investigation itself. Investigation deepens understanding, and deeper understanding enables sharper interpretation.

5. Iterative Refinement

Work productively when the first approach does not succeed. Complex investigations rarely proceed in a straight line. You will practice refining questions as preliminary results raise new ones, adjusting methods that prove inadequate, and recognizing when to pivot entirely. Productive struggle is a normal feature of authentic inquiry, not a sign that something has gone wrong. While this might sound easy, this is one of the most difficult skills to learn as most of your classroom experience has been with experiments that are designed to work without complications.

How This Course Works

This course is taught in a studio format. Most class time is spent actively working through investigations as a group, with frequent peer discussion, comparison of results, and instructor-led checkpoints. There is limited time spent on lectures. Come prepared to be actively engaged in doing experiments and using AI to solve problems.

Early investigations are heavily scaffolded. Whenever you learn something new, you apply it immediately and test it against real data and physical expectations, so that new knowledge becomes operational rather than superficial. As the semester progresses, the scaffolding falls

away and you take on more responsibility for designing analyses, choosing tools, and managing your own learning.

The last three weeks are devoted to an independent investigation of your own design, described under Independent Final Project below.

How Your Grade Is Determined

The percentages listed below indicate the percentage each category contributes to your final grade.

1 — Guided Investigations

40%

A sequence of investigations built around smartphone sensors as well as exploring how to use AI for a broader range of scientific processes. Planned topics include:

- Conducting AI supported literature research
- Evaluating the use of AI for assessment
- Using AI to build simulations and evaluating the benefits to learning
- Characterizing uncertainty in digital measurements
- Analyzing linear motion using GPS
- Characterizing linear and rotational motion using accelerometers and gyroscopes
- Measuring changes in pressure over a range of time scales to explore atmospheric pressure as well as sound waves.
- Investigating waves and applying digital signal processing techniques
- Exploring physiological signals associated with the cardiac cycle and neurological tremors.

The specific set and order may shift as the semester develops; the course website always carries the current plan.

Each investigation carries its own set of deliverables, which will be called out in the Student Guide for each lesson. Depending on the lesson, they may include a prelab tutor session, a report on your analysis, a short reflection, or a specific piece of data or code. Every lesson will include answering retrieval practice questions. The mix varies because the investigations vary — a lesson built on using AI to support literature research asks something different of you than one built around investigating sound waves.

What we assess is engagement. A prelab tutor session earns credit when you work through it seriously and answer honestly, not when you get every question correct. A report earns credit when it shows what you did, what you found, and how you checked it — not when it is elegantly written by the AI. Retrieval questions are there to strengthen your memory and build your understanding, and you get credit for attempting them thoughtfully whether or not you get them right the first time.

Overall, we are looking for evidence that you did the work and thought about it. We are not reading word by word, marking grammar, or comparing your results against an answer key. A rough report that shows real reasoning and an honest account of what went wrong will score better than a polished one that does not illustrate your thought process.

Complete a lesson's deliverables with genuine effort and you should expect full or near-full credit for it. The failure mode we do penalize is not turning in the work, or going through the motions — a tutor session clicked through in four minutes, a report that reads as though a chatbot wrote it and you did not check it, retrieval questions answered at random. All deliverables are due within 7 days of the completion of the lesson.

2 — Class Participation and Engagement

20%

Because learning here happens primarily through active inquiry and exchange with peers, participation is essential. It includes:

- Contributing observations and questions during class
- Sharing intermediate results and sticking points with your peers
- Engaging respectfully in group discussion
- Arriving prepared and working seriously through investigations

Participation is assessed on consistency, quality of engagement, and willingness to grapple with complexity — never on having the correct answer.

3 — Independent Final Project

30%

In the final three weeks you will carry out an independent investigation of your own design. You will:

- Propose a question involving a measurable phenomenon
- Design a data collection strategy using available sensors
- Conduct both a baseline analysis and an AI-assisted analysis
- Validate and interpret your results
- Reflect on your learning process and on your partnership with AI
- Provide peer feedback

Each of you will conduct your own project, but you are encouraged to discuss your work with classmates and to draw inspiration from your peers and your AI co-investigator.

Deliverables

- **5%** — Project proposal
- **20%** — Final presentation
- **5%** — Reflective analysis of your learning and AI use

This project is the primary demonstration of the skills you develop across the semester.

4 — Learning Reflections

10%

Short reflective assignments spread through the semester, focused on:

- How you formulated your questions
- How you identified gaps in your own understanding

- Which verification strategies proved effective
- How your use of AI evolved over time

Grading Scale

Final grades use the standard scale, applied to your weighted average.

A / A-	93 and above / 90 – 92.9
B+ / B / B-	87 – 89.9 / 83 – 86.9 / 80 – 82.9
C+ / C / C-	77 – 79.9 / 73 – 76.9 / 70 – 72.9
D / F	60 – 69.9 / below 60

Semester at a Glance

When	Focus
Week 1	Course Introduction
Weeks 2–11	New topics will be introduced each week. Each class will have a prelab assignment, an in-class activity, and a post class assignment.
Weeks 12–15	Independent investigation, final presentations, and reflection

Course Policies

Use of AI

You are expected to use AI extensively in this course. It is a required tool, not an optional aid, and using it well is one of the skills being taught and assessed. When an assignment is to be completed without AI — usually the manual first pass at a new analysis — we will say so explicitly in the instructions.

Two expectations come with that freedom. First, you are responsible for everything you submit: if AI generated it and it is wrong, it is wrong under your name. You will regularly be directed to use AI in helping you generate graphs, tables, simulations, and reports. You are expected to review, validate, and edit as appropriate everything that is turned in as work product in this course.

Everyone will have access to ChatGPT as provided by UC Merced. You may also use other AI tools of your choosing.

Academic Honesty

Every student in this course is expected to abide by the UC Merced Academic Honesty Policy. Plagiarism is the use of another person's ideas or words without proper attribution. It includes copying from the work of others into your own assignments without attribution or presenting such work as your own; using another's views, opinions, or insights without acknowledgment; and paraphrasing another's ideas without proper attribution. Credit must be given for every direct quotation, for any work you paraphrase or summarize in whole or in part, and for information that is not common knowledge. This applies to published sources, to material found through electronic searches, and to unpublished sources.

Because AI is a required tool here, the line is drawn differently than in many courses: using AI is not a violation, but misrepresenting how you used it is. Never present AI-generated work as unassisted, and be straightforward with us about how you worked if we ask.

The full policy is available at <http://studentconduct.ucmerced.edu/>.

Attendance and Late Work

Because nearly all of the work happens during the class sessions, it is critical that you be present and engaged during class. We recognize that illness, emergencies, and other **unexpected** obstacles happen. In those cases, you must reach out as soon as you are able so we can discuss whether accommodations will be possible.

- Guided Investigations: We will drop your two lowest Guided Investigation scores. This covers the investigation work for two missed sessions and does not additionally affect your participation score.
- Some investigations run across two class periods and are scored as a single investigation. If you miss one of the two periods, come see us and we will work out a solution.
- Participation: Absences beyond the first two are reflected in your participation and engagement score.
- Final presentations: You are expected to attend all final presentation sessions, both to present your own work and to hear your classmates. If you cannot make your assigned slot, contact us in advance and we will arrange an alternative. An unexcused missed presentation receives no credit.
- Late assignments: 2.5% deducted for each day late, up to one week. After one week, you will receive a grade based on the deliverables that have been turned in for that lesson.

Excused Absence Policy: You may request that the instructor excuse an assignment for reasons that include a major religious holiday, documented illness or family emergency, immigration or citizenship meeting, official university business (including athletic competitions and conference travel), etc. Please email the instructor, ideally before the absence, but as soon as possible in any case. An excused absence removes the affected assignment from your grade calculation rather than counting as a zero, and does not affect your participation score.

These policies exist because the work genuinely happens in the room, not to police attendance. If you are struggling to be here, talk to us early and we will find a way through it.

Working with Data from Your Own Body

Several investigations in this course involve recording signals from your own body — hand tremor with the accelerometer, blood volume changes at your fingertip with the camera (PPG), and cardiac electrical activity with an ECG sensor. These recordings are made for instruction. They are not medical tests, the sensors are not medical instruments, and neither we nor any AI tool used in this course can tell you anything about your health.

Your recordings belong to you. You decide what to collect, what to analyze, and what to share. Keep in mind that when you upload a file to an AI assistant it leaves your device and goes to a company's servers under that company's terms — treat anything you upload as no longer private. Do not upload a classmate's recording without their permission and leave names and identifying details out of any file you share with an AI tool or submit for grading.

Any recording you submit is stored with the rest of your coursework and is deleted at the end of the semester. We do not keep, share, or reuse your physiological data beyond this course.

If you would prefer not to use your own body as the data source, at any point and for any reason, tell us and we will set you up with an alternative:

- Work from a published physiological dataset, such as those on PhysioNet
- Analyze a recording that an instructor provides
- Partner with a classmate who has volunteered their data

You never owe us an explanation for making that choice, and it has no effect on your grade.

One last thing. Occasionally a measurement will look strange — an irregular interval, a rate higher or lower than you expected. In a course like this, that is almost always an artifact of a phone sensor, a loose contact, or motion during the recording, and learning to recognize such artifacts is part of the work. It is not a finding about you. If you do have a genuine concern about your health, please speak with a clinician.

Honors Section (SPARK 001H)

The Honors section carries out the same investigations, with additional depth required in the independent project and extensions to selected guided investigations.

Student Accessibility

The University of California, Merced is committed to creating learning environments that are accessible to all. If you anticipate or experience physical or academic barriers based on a disability, please feel welcome to contact me privately so we can discuss options. In addition,

please contact Student Accessibility Services (SAS) at (209) 228-6996 or access@ucmerced.edu as soon as possible to explore reasonable accommodations. All accommodations must have prior approval from Student Accessibility Services on the basis of appropriate documentation.

If you anticipate or experience barriers due to pregnancy, temporary medical condition, or injury, please feel welcome to contact me so we can discuss options. You are encouraged to contact the Dean of Students for support and resources at (209) 228-3633 or <https://studentaffairs.ucmerced.edu/dean-students>.

Student Support and Campus Resources

UC Merced offers a variety of resources to support your academic success, health, well-being, and safety listed online at <https://success.ucmerced.edu/>. You are encouraged to make use of these services whenever they may be helpful to you and include:

Basic Needs and Food/Housing Support

UC Merced's Basic Needs services support students experiencing food insecurity, housing concerns, financial challenges, or other basic-needs difficulties. Resources include the Bobcat Pantry, emergency food and housing assistance, CalFresh support, and referrals to additional campus and community resources.

Counseling and Psychological Services (CAPS)

CAPS provides confidential mental health services to UC Merced students, including individual and group counseling, crisis support, consultation, and workshops. Students do not need to be experiencing a crisis to seek support.

CARE Office (Campus Advocacy, Resources & Education)

The CARE Office provides free, confidential support, advocacy, and resources related to sexual violence, sexual harassment, dating/domestic violence, and stalking. CARE advocates can help students understand their options and access medical, academic, legal, and other forms of support.

Office for the Prevention of Harassment and Discrimination / Title IX

UC Merced provides resources for students who experience discrimination, harassment, sexual harassment, sexual violence, or other forms of prohibited conduct. Students may contact the appropriate campus office to learn about reporting options, supportive measures, and university policies. Please be aware that some university employees, including instructors, may have obligations to report certain disclosures to the university.

Student Health Services

Student Health Services provides medical care and health-related services to enrolled students, including primary and urgent care, preventive services, immunizations, and health education.

For current contact information, hours, eligibility requirements, and services, consult the UC Merced website or the appropriate campus office. If circumstances are affecting your ability to participate in this course, you are also welcome to contact us. You do not need to disclose private or sensitive details; we can help you identify appropriate academic options and campus resources.