ASEN 6519 Artificial Intelligence for Aerospace Systems (AI4Fly)

Fall 2025 Syllabus

Lecture: AERO N250 Tuesday and Thursday, 11:30 AM – 12:45 PM

Instructor

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Hours: TBD

Text

Required: None

Prerequisites

This class is open to graduates with a background in autonomy, robotics, and dynamics and control. Students should have taken at least one of ASEN 5014 Linear Systems, ASEN 5254 Algorithmic Motion Planning, ASEN 5128 Small UAS Guidance and Control, or ASEN 5264 Decision-Making Under Uncertainty or equivalent course.

Overview

The purpose of this course is to introduce students to concepts, techniques, and tools from artificial intelligence with focus on topics that apply to aerospace systems. The course will be divided into four sections that progress from broad coverage of fundamental topics to deeper investigation into one or two areas, to implementation, and finally to flight testing and evaluation.

Artificial intelligence (AI) is viewed as a critical technology across almost every aspect of society, including aerospace engineering. In many cases AI is conflated with machine learning, however it covers a much broader set of concepts, techniques, and tools. Thus, the first quarter of the course will establish a broad foundation by presenting multiple topics that are all elements of AI. Students will obtain sufficient understanding of these topics to describe the technical fundamentals of the concept, technique, or tool; to determine when and how it is appropriate to incorporate them into an aerospace system; and to explain key issues or limitations.

For the second quarter of the course, students will identify one or two topics for deeper coverage and exploration. This exploration will include finding, reading, presenting, and discussing contemporary archival publication. Discussion will emphasize a balance between theoretical understanding and practical applicability.

During the third quarter of the semester students will work in small groups to implement material selected from the deep investigation of the second quarter. Here, students will obtain existing

tools, e.g. open source software packages or algorithms published in archival journals, and combine them with their own programming in order to create software that can be integrated into existing small uncrewed aircraft systems (UAS).

Finally, with help from the CU Integrated Remote and In Situ Sensing (IRISS) program, students will carry out testing and evaluation on real hardware. This hardware will include fixed-wing and/or multirotor UAS managed by IRISS. Students will act as the chief scientists / mission leads while the IRISS team conducts all flight operations for data collection.

Topics covered in the first section of the course include:

1. Nomenclature, definitions, and abstraction models
2. Nonlinear model predictive control
3. Kinodynamic motion planning
4. Swarming and cooperative control
5. Decision making under uncertainty
6. Neural networks for machine learning
7. Gaussian processes and other machine learning techniques
8. Large language models and foundation models
9. Fault detection
10. Health management and self-awareness

Course Grading

20% Paper review discussion (individual)
30% First Quarter Summary Report and Second Quarter Recommendation (individual)
30% Third Quarter Implementation Design and Assessment (small group)
20% Final Project Report (small group/full class)

Course Readings

The schedule for course reading material is provided in a separate document. Students are expected to complete the reading assignments **before** the class on the date on which they are listed. The majority of work expected of students outside of class time during the first half of the course is reading the material.

University Policies

Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the Honor Code may include but are not limited to: plagiarism (including use of paper writing services or technology [such as essay bots]), cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. Understanding the course's syllabus is a vital part in adhering to the Honor Code.

All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution: StudentConduct@colorado.edu. Students found responsible for violating the Honor Code will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to academic sanctions from the faculty member. Visit Honor Code for more information on the academic integrity policy.

Accommodation for Disabilities, Temporary Medical Conditions, and Medical Isolation

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website. Contact Disability Services at 303-492-8671 or DSinfo@colorado.edu for further assistance. If you have a temporary medical condition, see Temporary Medical Conditions on the Disability Services website. If you have a temporary illness, injury or required medical isolation for which you require adjustment, notify the instructor as soon as possible.

Accommodation for Religious Obligations

Campus policy requires faculty to provide reasonable accommodations for students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Please communicate the need for a religious accommodation in a timely manner. See the campus policy regarding religious observances for full details.

Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Classroom Behavior

Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, marital status, political affiliation, or political philosophy. For more information, see the classroom behavior policy, the Student Code of Conduct, and the Office of Institutional Equity and Compliance.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits protected-class discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner abuse (dating or domestic violence), stalking, and related retaliation by or against members of our community on- and off-campus. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who have been subjected to misconduct can contact OIEC at 303-492-2127 or email CUreport@colorado.edu. Information about university policies, reporting options, and OIEC support resources including confidential services can be found on the OIEC website. Please know that faculty and graduate instructors are required to inform OIEC when they are made aware of incidents related to these concerns regardless of when or where something occurred. This is to ensure that individuals impacted receive outreach from OIEC about their options and support resources. To learn more about reporting and support for a variety of concerns, visit the Don't Ignore It page.

Mental Health and Wellness

The University of Colorado Boulder is committed to the well-being of all students. If you are struggling with personal stressors, mental health or substance use concerns that are impacting academic or daily life, please contact Counseling and Psychiatric Services (CAPS) located in C4C or call (303) 492-2277, 24/7.

Free and unlimited telehealth is also available through Academic Live Care. The Academic Live Care site also provides information about additional wellness services on campus that are available to students.

Acceptable Use of AI in this Class

Generative artificial intelligence tools (Gen-AI)—software that reproduces text, images, computer code, audio, video, and other content—have become widely available. Well-known examples include ChatGPT for text and DALL•E for images. This statement governs all such tools, including those released during the semester. Keep in mind that the goal of gen AI tools is to reproduce content that seems to have been produced by a human, not to produce accurate or reliable content; therefore, relying on a Gen-AI tool may result in your submission of inaccurate content. It is your responsibility—not the tool's—to assure the quality, integrity, and accuracy of work you submit in any college course. If Gen-AI tool use is suspected in completing assignments for this course in ways not explicitly authorized, I will follow up with you. I may contact the Office of Student Conduct & Conflict Resolution to report suspected Honor Code violations. In addition, you must be wary of unintentional plagiarism or data fabrication. Please act with integrity, for the sake of both your personal character and your academic record.

As this is a course on artificial intelligence, the use of Gen-AI is encouraged. You may conditionally use Gen-AI tools in this course on **any** assignment. Gen-AI use is permitted for the purpose of i.) creating implementation of algorithms, ii.) creating imagery of concepts, block diagrams, example applications but not to generate figures with fake data or results, iii.) as

background research to motivate or explain concepts. Gen-AI **may not be used** to write full paragraphs of text or provide itemized lists for direct inclusion in submissions. In all cases there must be clear attribution and explanation of Gen-AI's role in the completion of the assignment. If you use Gen-AI tools on assignments in this class, document your usage with the Chicago Manual of Style or appropriate citation guidelines for this course.